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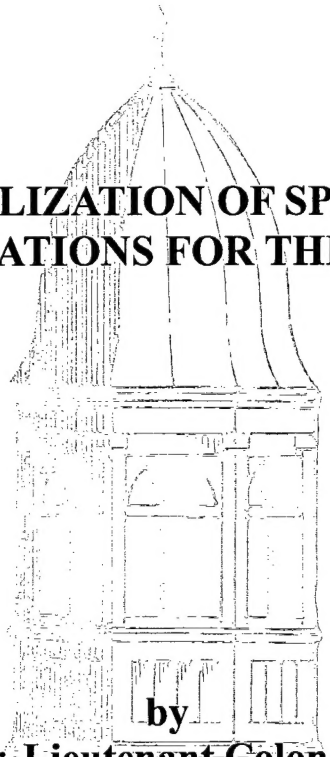
COMMERCIALIZATION OF SPACE SYSTEMS: POLICY IMPLICATIONS FOR THE UNITED STATES



by

Dennis M. Miller, Lieutenant Colonel, U.S. Air Force
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15.Abstract: Commercialization of Space Systems is a topic of growing interest in national security and thus has significant implications for the government and commercial sector. Commercial industry, international consortia, and many nations such as India, China, France, Russia and Canada are now challenging the U.S. government preeminence in space. As U.S. capabilities and national dependence on space continue to increase, the commercial developers are finding new applications to market to government as well as private sector organizations. This study investigated how the military and government currently use commercial space systems to determine if the current policies are coherent and consistent, how the policies are being implemented, problems with policy implementation, and defining elements for a new policy. The findings of this study are that the U.S. needs more directive, active policies; the U.S. government should establish a commercial space systems czar to provide clear guidance and strong national leadership; the United States needs to develop a National Space Security Strategy; the United States must invest in critical technologies to maintain its space technology industrial base; the U.S government must become a better consumer of commercial space systems by establishing a budget process that simplifies the ability to use these products and services; the U.S. government should establish and comply with standards and procedures for commercial space systems interoperability, export control, and licensing; and, finally, the U.S. government must decentralize how it controls the use of commercial space systems.

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As an Advanced Research Project

This paper was completed as an independent research project in the Advanced Research Department, Center for Naval Warfare Studies, Naval War College. It is submitted to the faculty of the Naval War College in partial satisfaction of the academic requirements for the degree of Master of Arts in National Security and Strategic Studies. As an academic study completed under faculty guidance, the contents of this paper reflect the authors' own personal views and conclusions, based on independent research and analysis. They do not necessarily reflect current official current policy in any agency of the U.S. government.

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ABSTRACT

This study discusses commercial space systems in terms of how well current policies and directives have contributed to increasing the availability and survivability of commercial space systems for use by the U.S. government. It examines specific problems and pitfalls that are associated with these policies, and addresses how the United States can minimize these problems as it develops and uses commercial space systems in the future.

The purpose of this paper is threefold. First, it identifies specific commercial services and the critical developments in the field of commercial space systems that support the needs of the U.S. government. Second, it describes specific U.S. government policies and regulations that govern how and to what extent military and governmental organizations are able to use commercial space products. Third, it assesses the effectiveness of these policies, and provides recommendations that seek to balance the increasing use of commercial space systems with protecting U.S. national interests and security.

This is the proper time for the U.S. government to consider the following recommendations that are designed to emphasize the value of using commercial space systems while protecting and enhancing U.S. national interests. Specifically, the United States should: (1) reorganize for effective policy implementation; (2) develop a national space security strategy; (3) invest in critical technologies to maintain the space technology industrial base; (4) become better consumers of commercial space systems by establishing a budget process that simplifies the ability to use commercial space systems products and services; (5) establish and comply with standards and procedures for commercial space systems, interoperability, export control, and licensing; and (6) educate commercial firms on the threats and risks to space systems.

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Dennis M. Miller, Lieutenant Colonel, USAF, is a Distinguished Graduate in ROTC and has a Bachelor of Science Degree in Electrical and Electronic Engineering from North Dakota State University. His first assignment was with the 1000th Satellite Operations Group, Offutt AFB, Nebraska as a test and integration engineer who was responsible for supporting the Defense Meteorological Satellite Program operations. In May 1985, he was transferred to Wright-Patterson AFB, Ohio as a student at the Air Force Institute of Technology (AFIT), where he specialized in digital engineering and computer network design. After earning a Master of Science Degree from AFIT in 1986, he was reassigned to Headquarters, Air Force Operational Test and Evaluation Center (AFOTEC), Kirtland AFB, New Mexico where he served as the operational test manager for the Milstar program. In January 1990, he was assigned to the Milstar Operational Test Team, Detachment 4 AFOTEC, at Peterson AFB, Colorado as the Deputy Test Director for Multi-Service Operations and Mission Control Segment. After Lieutenant Colonel Miller graduated in 1994 as a Distinguished Graduate of the Air Command and Staff College at Maxwell Air Force Base, he was assigned as the Director for the Plans and Resources Division at the 46th Test Group, Holloman AFB, New Mexico. In October 1996, he was reassigned as Chief, Space Operations and Policy, Headquarters Air Force Test and Evaluation, Pentagon, Washington D.C. In July 1998, he assumed command of the 746th Test Squadron, and then was selected to attend the Naval War College. Lieutenant Colonel Miller is married to the former Amy Bass of Sikeston, Missouri. They have one son, Sean and two daughters, Kelsey and Shannon. After graduation from the Naval War College, Lieutenant Colonel

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SECTION I

INTRODUCTION

The 1991 Persian Gulf War, which was considered to be "the first space war," demonstrated for the first time that space systems bring an important capability to the battlefield.[1] During the last ten years, space has emerged as a significant factor for military success, and is an integral part of military operations and will continue to be for the foreseeable future.[2] According to General Richard B. Myers, "United States (U.S.) military power is now directly reflected in U.S. space power."[3] The Gulf War also marked the first time that commercial and civilian communications and observation satellites helped to meet the growing demand of U.S. and allied military forces for information. For example, during the Gulf War commercial satellites provided 20 percent of the total satellite communications capacity.[4] Today, commercial satellite leases provide roughly 60 percent of the U.S. military's satellite communications.[5] This dependence on commercial systems is partly the result of rapid growth in commercial space activity as well as a decline in resources committed to defense.

As a result, commercial space systems are seen by the military services and intelligence agencies as a way to offset fiscal limitations, which are forcing the military to

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[1] Secretary of Defense William Cohen Memorandum, "DoD Space Policy," July 9, 1999, who noted that, "Space Power is as important to the nation as land, sea, and air power. It is a strategic enabler of the National Military Strategy and Joint Vision 2010."

[2] General Richard B. Myers, "Achieving the Promise of Space - The Next Step" *Air Force Association Warfighting Symposium*, Orlando, Florida, February 4, 1999.

[3] *Ibid.*

[4] Peter Brier, "The Data Weapon," *Government Executive*, June 1992, p. 21.

[5] Katie McConnell, "Military Satellite Communications: The March Toward Commercialization," *DDN Special Reports*, <http://www.defensedaily.com/reports/satcom_4.htm> [April 15, 2001].

rethink its justification for space systems and develop dual-use systems. In fact, the Air Force's Total Obligation Authority (TOA) has declined by 39 percent since fiscal year 1986, while the TOA devoted to space has remained virtually constant.[6]

The policies that govern the use of commercial space systems have been the subject of debate for decades.[7] In 1993, the Department of Defense (DoD) promulgated new policy guidance for the use of commercial satellite communications based on the congressionally

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[6] Headquarters Air Force Space Command and Headquarters Space and Missile Systems Center, *Final Report Commercial Space Opportunity Study (CSOS)*, February 16, 2001, p. 1.1.

[7] For background on scholarly research and studies on the policies that govern the use of space systems and technologies, see Edward E. Aldridge, "Myths of the Militarization of Space," *International Security*, Spring 1987, pp. 151-56; Mark Alpert, "Making Money in Space," *Scientific American*, 1999; *Applications of Commercial Satellite Technology – Forecasted Trends for 2005 – 2007* (Washington, D.C.: National Reconnaissance Office – Aerospace Corporation, 1999); *Commercial Space Opportunities Study* (Colorado Springs, CO: Air Force Space Command – Space and Missile Center, 1999); *Communications Architecture Study* – CAS (Los Angeles, CA: Space and Missile Center, 1999); Ann M. Florini, "The Opening Skies: Third-Party Imaging Satellites and U.S. Security," *International Security*, Fall 1988, pp. 91-123; *Global Satellite Marketplace 99* (New York, NY: Merrill Lynch, 1999); Vipin Gupta, "New Satellite Images for Sale," *International Security*, Summer 1995, pp. 94-125; Dana J. Johnson, Max Nelson, and Robert J. Lempert, *U.S. Space-based Remote Sensing: Challenges and Prospects* (Santa Monica, CA: The RAND Corporation, 1993); Dana Johnson, Scott Pace, and C. Bryan Gabbard, *Space: Emerging Options for National Power* (Santa Monica, CA: The RAND Corporation, 1998); Frank G. Klotz, Space, *Commerce, and National Security* (New York, NY: Council on Foreign Relations, 1998); Irving Lachow, "The GPS Dilemma: Balancing Military Risks and Economic Benefits," *International Security*, Summer 1995, pp. 126-148; *Leveraging Commercial Communications Satellite Technology and Investment to Meet Defense Needs* (Washington, D.C.: U.S. Department of Defense, Director Defense Research and Engineering, MITRE Corporation, 1998); *Leveraging Commercial Satellite Systems for Future Military Applications* (Los Angeles, CA: Aerospace Corporation, 1999); *MILSATCOM Integrated Satellite Communications Study* (Los Angeles, CA: Space and Missile Center/MCX, 1996); Thomas S. Moorman, Jr., "The Explosion of Commercial Space and the Implications for National Security," *Airpower Journal*, Vol. 13, No. 1, 1999; Theodore C. Moran, "The Globalization of America's Defense Industries: Managing the Threat of Foreign Dependence," *International Security*, Summer 1990, pp. 57-99; *New World Vistas: Air and Space Power for the 21st Century* (Washington: U.S. Air Force Scientific Advisory Board, 1995); *Potential Legal, Regulatory, and Policy Pitfalls for Military Use of Commercial SATCOM* (Los Angeles, CA: Aerospace Corporation, 1999).

mandated Commercial Satellite Communications Initiative Study. The premise was that there are demonstrable benefits from increasing the use of commercial satellite communications in military operations.[8] The intent of this guidance was to give the DoD an opportunity to help meet the requirements of operational commanders at a time of fiscal constraints. In principle, commercial satellite communications could provide more capability by reducing the number of satellites owned or operated by DoD, and reduce the cost of satellite services by spreading the cost among many commercial, military, and intelligence users.

Furthermore, the Clinton Administration issued the U.S. National Space Policy in 1996, which directed the United States to maintain its leadership by advancing space technologies and programs in all areas, including weather, remote sensing, and communications systems.[9] In addition to establishing guidance for U.S. space activities, this space policy also directed that there be greater interaction between governmental and commercial organizations.[10] To accomplish this objective, U.S. policy encourages the use of commercial space systems whenever possible to ensure that the United States can provide the cost effective space applications and services that will satisfy U.S. and DoD requirements.[11]

However, the "Doable Space" Quick Look Study conducted in 1997 by the Chief Scientist of the Air Force concluded that the "military potential of commercial space was not well defined or understood. It recommended that the Air Force conduct an aggressive study

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[8] Department of Defense, *Report on the Bottom Up Review*, October 1993, pp. 65-68.
[9] White House, Office of the National Science and Technology Council, *Fact Sheet - National Space Policy*, September 19, 1996. <http://www.fas.org/spp/military/docops/national/nstc-8.htm> [April 9, 2001].
[10] *Ibid.*
[11] *Ibid.*

on exploiting the space commercial revolution."[12] As result of numerous studies, the DoD published new policies governing the use of commercial systems in 1999.[13]

With this as background, this study examines whether these policies and directives are increasing the availability and survivability of commercial space systems. It considers specific problems and pitfalls with these policies, and addresses how we can avoid or minimize these problems in the future. Finally, it concludes with specific recommendations for improving the policies governing how the military services and government agencies use commercial space systems. This is the framework within which this study was conducted.

Hypothesis. This study investigates the policies that govern the ability of military and governmental organizations to use commercial space systems. While there are numerous policies that have promulgated by government agencies on the use of commercial space systems, there are sharply divergent views within the military and government about whether the United States should encourage the development and use of commercial space systems. The fundamental hypothesis is that the United States should develop more active and effective policies that encourage government organizations to use these systems.

Background. During the last decade satellite systems have become increasingly important to the ability of U.S. military forces to project power and conduct military operations on a global basis. Rapidly growing information requirements and the increasing unpredictability of where and against whom the U.S. military may be called to fight have combined to increase the value of satellite systems. In order to be able to project power on a

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[12] Headquarters Air Force Space Command, p. ES-1.

[13] The major studies include "*National Defense Industrial Association/CINCSPACE Summer Study*" (briefed September 25, 1997), *Doable Space Quick Look Study* (briefed February 11, 1998), *A Space Roadmap for the 21st Century Aerospace Force* (1998), and *Commercial Space Opportunity Study (CSOS)* (1999).

global basis, military operations increasingly depend on space-based systems for warning, surveillance, reconnaissance, navigation, and communications. At the same time, the DoD has become increasingly dependent on using commercial space systems to augment military and national space systems. This development has been most evident in the fields of commercial satellite communications and, even more recently, in the emergence of commercial firms, which specialize in providing high quality, high-resolution satellite imagery and radar imagery products. This development suggests that the military should carefully evaluate the value of exploiting these capabilities.

Commercial satellite applications and services are evolving into a significant global business, as exemplified by the growth of mobile communications and navigation services that depend on the Global Positioning System (GPS). In fact, revenues from commercial space firms have grown dramatically from $26 billion in 1996 to $60 billion in 1998, and are projected to reach over $170 billion in 2007.[14] Today, more than 1,000 companies worldwide are involved in the business of developing, manufacturing, and operating space systems.[15] In 1997, there were more commercial space launches than launches by the U.S. military, the National Reconnaissance Office (NRO), and the National Aeronautics and Space Administration (NASA). In the foreseeable future, U.S. government launches are projected to account for a very small percentage of the total number of launches.[16] In May 1998, for the first time in the history of space development, there were more commercial than

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[14] Glenn Goodman, Jr., "Hitching A Ride," *Armed Forces Journal International,* July 1998, pp. 39-41.
[15] *Ibid.*
[16] Mark Hewish, "Military Takes a Giant Leap With Commercial Space Technology," *Jane's International Defense Review*, April 1999, p. 41. See also John T. Correll, "A Roadmap for Space," *Air Force Magazine*, March 1999, pp. 20-25.

military satellites on orbit.[17] To complicate matters, the U.S. military has relied heavily on commercially developed systems to provide leading-edge communications, as exemplified by direct broadcast television and mobile telephone services.[18] According to U.S. Space Command's Long Range Plan, the United States' reliance on space will continue to increase for both military and commercial applications and services.[19]

At the same time, the transparency of global information is having a profound effect on military planning and operations. Commercial space growth will cause the United States to be more dependent in the future on commercial space assets. Satellites will increase the degree of global transparency and encourage the collection and use of data and information that readily and instantaneously bypasses national boundaries.[20] In addition, it is an article of faith that satellites directly enhance the power and prestige of the states that possess them. A revolutionary development is that in the twenty-first century any organization with sufficient resources can use satellites to monitor the actions of others and use a global communication network to easily pass that information to any location on the globe. With more than 35 nations and seven international companies or consortia involved in space, the potential uses of space systems available to allies and adversaries is bound to increase.[21] In fact,

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[17] Tome Riebe and Matt Schweitzer, "Space Operations and Support," *Aerospace America*, December 1998, p. 83.

[18] Bill Gregory, "Covering the Globe," *Armed Forces Journal International*, July 1998, pp. 36-18, and Goodman, pp. 39-41.

[19] U.S. Space Command, *Long Range Plan: Implementing USSPACECOM Vision for 2020* (Peterson AFB, Colorado: March 1998), <http://www.peterson.af.mil/usspace/LRP.htm> [April 3, 2001].

[20] John C. Baker and Ray A. Williamson, "The Implications of Emerging Satellite Information Technologies for Global Transparency and International Security," in Bernard I. Finel and Fristin M. Lord (editors), *Power and Conflict in the Age of Transparency* (New York, NY: Palgrave, 2000), p. 221.

[21] Air Force Association, "Space Almanac," Air Force Association Homepage, <http://www.afa.org/magazine/space/upthere.html> [April 3, 2001].

commercial space consortia are increasingly multinational enterprises that use global interdependence to take advantage of the infrastructure, expertise, and equipment that exists within many nations.

In the future, the United States may find that its adversaries could have access to the same commercial space systems when they conduct military operations. For example, the U.S. Air Force was a significant customer of commercial satellite imagery that was generated by the French SPOT satellite during the Persian Gulf War.[22] To cite another case, the U.S. military already has competed with such users as Cable News Network (CNN) to buy excess capacity, and could find that commercial firms buy out the market before the military realizes that it needs to acquire commercial space systems to support an operation in a theater of operations. This occurred during the military operation in Kosovo in 1999. Fundamentally, global information transparency will make it more difficult to achieve surprise, require better planning, and make it easier to develop a successful strategy for dealing with the United States.

There are several factors that determine the right balance between commercial and military systems, including the fact that current military systems must be replenished in the first decade of this century; competition for access to space that is enhanced by political and economic forces; the expansion of commercial satellites, capabilities, and services on a domestic and international basis; the changing and growing needs and requirements of the operational forces; and finally, the realization that DoD cannot fill all of these requirements by itself.

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[22] James A. Winnefeld, Preston Niblack, and Dana J. Johnson, *A League of Airmen: U.S. Air Power in the Gulf War* (Santa Monica, CA: The RAND Corporation, 1994), p. 201.

The policy implication is that the United States must be sure that its policies help, or at least do not hinder, the efforts of commercial firms that develop advanced space technologies and systems. At the same time, those who argue that commercial space systems are necessary might benefit from a deeper understanding of the risks associated with increased dependence on commercial space systems. Competing demands for space capabilities by U.S. allies, commercial industry beyond CNN, the stock market (global market), global movement (city planning), global communications such as Internet and cell phones and even U.S. adversaries will be huge in the future. Consequently, protection of these vital assets is critical to U.S. economic and military security. In essence, the U.S. and international policies that govern the use of commercial space systems should create opportunities for government and commercial organizations to strike the proper balance between commercial interests and national security interests. The challenge is to establish rules and standards for operating commercial space systems that are politically, economically, and militarily acceptable.

Scope. To understand the evolving relationship among military, civil, and commercial space interests, this study examines whether current U.S. policies and directives provide the appropriate level of guidance for increasing the availability and survivability of commercial space assets in terms of an overview of commercial space systems, a review of applicable U.S. policies and guidance, and an evaluation of these policies. The first area defines specific commercial products and critical developments in the field of commercial space systems that support the needs of the U.S. military and government. The second area describes specific U.S. government policies and regulations that govern how and to what extent military and governmental organizations are able to use commercial space products.

The last area assesses the effectiveness of these policies to determine if a new framework for U.S. government agencies that shapes the use of commercial space systems in the twenty-first century is needed.

Although the U.S. military and government agencies will need commercial space systems for the foreseeable future, this study does not consider the use of space-based position, navigation, and timing information. The reason is that U.S. government satellites, notably the GPS, will continue to meet virtually all of the navigation demands of U.S. government users, and will continue to provide navigation and timing signals free-of-charge to private individuals, commercial firms, and foreign governments for the foreseeable future. It is likely that these navigation signals will provide sufficient accuracy to discourage foreign interests from launching competing systems.[23]

Research Approach. To understand the nature of U.S. policies and directives that govern the use of commercial space systems, this study reviews governing policies and directives, evaluates these policies and directives in terms of specific problems or pitfalls, and makes recommendations to resolve these problems. During the course of this research, the authors reviewed the existing literature on commercial space systems and conducted interviews with government officials at the Department of State (DoS), Department of Commerce (DoC), National Security Council (NSC) and the Office of Science and Technology Policy at the White House, NASA, National Imaging and Mapping Agency (NIMA), NRO, National Security Agency (NSA), Defense Information Systems Agency (DISA), National Security Space Architect (NSSA), Office of the Secretary Defense Net

[23] We should note, however, that the European Union is wrestling at the time of this writing with the decision of whether to build and deploy the Galileo navigation system, which is analogous to GPS.

Assessment, Undersecretary of Defense for Policy, Joint Staff, Secretary of the Air Force Space Policy, Headquarters Air Force Space Policy, Air Force International and Operations Law Division, U.S. Space Command, U.S. Strategic Command, Army Space Command, Naval Space Command, and Air Force Space Command. In addition, officials from various commercial firms and academic institutions also were interviewed. In all of these interviews, individuals were asked to identify specific recommendations that will improve the policies that govern how the United States uses commercial space systems.

SECTION II

SATELLITE COMMERCIALIZATION OVERVIEW

During the Second Wave era, military technology in the United States advanced at lightning speed and spun off innovation after innovation into the civilian economy. Today a role reversal has occurred. In the fast paced Third Wave economy, technical breakthroughs come faster in the civilian sector and spin off into the defense industries. This calls for a strategic reexamination of R&D priorities and a restructuring of relations.

--Alvin and Heidi Toffler
War and Anti-War[24]

Since the launch of Russia's first satellite, Sputnik, in 1957, the DoD has been involved with space. While space systems were used during the Cold War to support strategic missions, these systems have become increasingly essential to meeting U.S. security needs in the twenty-first century. During the 1960's, military satellite programs, along with civil programs, such as NASA, dominated the development and acquisition of satellites for military and intelligence purposes. In most cases, space applications, services, and products were dominated by extremely high levels of classification, which radically limited the ability to disseminate information about space systems with the possible exception of satellite communications. As a consequence, the concept of commercial space systems was not part of the military or commercial lexicon in the United States or elsewhere.

In military terms, space supports three fundamental types of applications. The first is communications, which involved relaying information between military commands and forward units on a global basis. The second is sensing, which seeks to provide information about objects on the earth for the purposes of environmental monitoring, warning and attack

[24] Alvin and Heidi Toffler, *War and Anti-War* (Boston, MA: Little, Brown, and Company, 1993), p. 29.

assessment, reconnaissance and mapping, charting, and geodesy. Third, space systems are used for locating objects of interest, navigation, and search and rescue.[25]

With the end of the Cold War, the demands of the U.S. military have increased despite the fact that defense budgets are shrinking in real terms. Since 1985, the Pentagon's budget has decreased by 38 percent, but this has been accompanied by a dramatic increase in the commitments of the U.S. military and a decline in the number of personnel.[26] The U.S. Air Force budget for space, for example, is about $7 billion a year in an annual budget of $75 billion, of which $4.1 billion is spent on new systems with the remainder devoted to operating and maintaining existing space systems.[27] However, this funding is insufficient to address the requirements. For example, the 2001 defense budget does not cover the present baseline for space systems or fund the proposed initiatives and improvements that are generally believed to be necessary to maintain U.S. technological superiority.[28] To reverse this trend, the United States would need to increase its spending by 20 percent to provide the capabilities that are outlined in the U.S. Space Command Long Range Plan.[29]

To maintain the ability of the United States to project military power and conduct military operations on a global basis, commercial space systems are increasingly being integrated into military operations. The rapidly growing demand for information in juxtaposition with uncertainties about whom and where the United States may be called upon

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[25] DoD Space Program, "An Executive Overview for FY 1998-2003," March 1997. <http://www.fas.org/spp/military/program/sp97/index.html> [April 4, 2001].
[26] McConnell.
[27] Correll, pp. 20-25.
[28] *Ibid.*
[29] General Accounting Office, *Defense Acquisitions: Improvements Needed in Military Space Systems' Planning and Education* (Washington, D.C.: GAO/NSIAD-00-81, General Accounting Office, May 18, 2000, <http://www.fas.org/spp/military/gao/nsiad-00-081.htm> [April 5, 2001].

to fight increases the importance of space technologies. The problem is that given current and future military space systems, the DoD will not be able to handle the demand for information.[30] As a result, U.S. space policy has gradually changed toward encouraging commercial firms to develop space products and services that will bolster economic prosperity, maintain the U.S. leadership in space, and reduce the need for the military to invest in space.[31] During the last decade, the focus of space products and services has shifted increasingly toward satisfying demands generated by the commercial sector.[32]

At the same time, there have been significant changes in the satellite industry in recent years. As each new generation of faster microchips emerges every 18 months,[33] commercial space technology is evolving at roughly the same pace.[34] Thus, the technological trend is for new systems, applications, and services to emerge on a regular basis.[35] In the commercial satellite market, constellations of satellite networks are beginning to emerge, of which Iridium is one example. Given improvements in satellite components, technologies, and production processes as well as declining production and operations costs, satellite systems are becoming more operationally and economically effective. The literature on commercial space systems generally reflects a sense of optimism about the future. For example, the report produced by the Futron Corporation, *Space Transportation and The*

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[30] Sandra I. Erwin, "Pentagon Investments in Space Guided by Commercial Options," *National Defense*, April 1998, pp. 20-22.

[31] White House, Office of the National Science and Technology Council.

[32] Katherine McIntire Peters, "Space Wars," *Government Executive,* April 1, 1998. <http://www.govexec.com/features/0498s1.htm> [April 5, 2001], which noted that, "The trend is clear: Commercial investment in space technology is fast outpacing government investment."

[33] Sydney J. Freedberg, "Future-Shock Troops," *National Journal*, December 11, 1999, <http://home.datawest.net/dawog/vaq132/s19991213future.htm> [April 13 2001].

[34] Goodman, pp. 39-41.

[35] Theresa Foley, "Commercial Spacefarers," *Air Force Magazine*, December 1998, p. 43.

Global Space Commerce Market, predicts that space revenues will grow from $51.2 billion in 1997 to $200 billion in 2007.[36] In addition, the Federal Aviation Administration predicts that there will be an average of 51 commercial space launches worldwide per year through the year 2010, which represents a 40 percent increase since 1998.[37] Government satellites are expected to account for only 20 percent of all satellite launches over the next ten years.[38] Of the remaining 80 percent of commercial space launches, commercial communications satellites will account for roughly two-thirds, while commercial imaging satellites represent one-third.[39] Given this level of growth, the global satellite industry will create an enormous range of choices for commercial and military consumers throughout the world.[40]

The remainder of this chapter focuses on two commercial space activities, communications and remote sensing, and ignores the navigation functions that are provided by government satellites. For communications and remote sensing, this discussion focuses on historical background, capabilities, current status, future trends, and military utility in

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[36] According to this forecast: "over the ten-year period the biggest change will occur in the U. S. military's presence in the space industry. Currently, the military holds 45 percent of all LEO's and 95 percent of all MEO in orbit. By 2007 these percentages are expected to change leaving the U.S. military with 15 percent of all LEO's and 65 percent of all MEO's." "Market Snapshot, Space Revenue Projections," *Satellite Today,* August 2, 1999, <http://www.satellitetoday.com/snapshot/previous/080299.htm> [April 6, 2001].

[37] "Market Snapshot, Launch Demand Projections," *Satellite Today,* July 19, 1999, <http://www.satellitetoday.com/snapshot/previous/071999.htm> [April 6, 2001].

[38] "Market Snapshot, Space Revenue Projections," *Satellite Today.*

[39] Marco Caceres, "Commercial Satellites Surge Ahead," *Aerospace America*, November 1998. <http://tealgroup.com/Articles/AeroSpaceAmerica/AeroSpaceAmericanNov98.htm> [April 9, 2001].

[40] It is important to note that these projections were a snapshot in time. The market is not as favorable as it was predicted two to three years ago. Although the market is healthy, it is not expanding as fast as predicted. Several companies have lost money or merged with other companies and the market appears to be shifting from large satellites to micro, nano, and pico satellites. Source: Marco Caceres, Senior Space Analyst for Teal Group, author interview, May 6, 2001.

order to establish a framework for analyzing how well current policies support the use of commercial space services and products.

Commercial Satellite Communications (SATCOM)

Satellite communications, which without a doubt is the most highly developed form of commercial space activity, was established with the passage of the 1962 Commercial Satellite Act. Since the launch in 1965 of the first communications satellite, Intelsat 1 (known as Early Bird), the use of communications satellites by the government, industry, and military has grown significantly. Today, Intelsat, an international commercial consortium, is the world's largest supplier of satellite communications.[41]

The 1990s signaled the emergence of the new wave of commercial satellite communications, as highlighted by the launch of the Iridium and Globalstar satellite constellations. More than ever, satellite communications play an important role in everyday governmental, business, and personal activities because these systems provide communications services, including television programs, telephone service, paging service, computers, service between ships and offshore facilities, and data and voice transmission services. At the same time, societies increasingly depend on these systems, as highlighted by the thousands of pager subscribers of the Hughes Galaxy 4 satellite who lost this service in

[41] "The consortium began on August 20, 1964 as the International Telecommunications Satellite Consortium with 11 participating countries. In 1973, the name was changed to International Telecommunications Satellite Organization (ITSO) and there were 80 signatories. ITSO currently has over 100 members and provides service to over 600 Earth stations in more than 149 countries, territories and dependencies. Intelsat maintains its' headquarters in Washington, D.C." *Mission and Spacecraft Library*, NASA/JPL/Caltech web page, <http://samadhi.jpl.nasa.gov/msl/Programs/intelsat.html> [April 6, 2001].

the spring of 1998.[42] Overall, 90 percent of pager customers in the United States suffered a loss of service.[43]

Nevertheless, the future for commercial communications is very promising, as exemplified by wide-ranging proposals for using satellite communications, including smaller antennae, greater bandwidth capacity, lighter, smaller, more mobile ground terminals, and geostationary and non-geostationary constellations of satellites.[44] Furthermore, these satellites will be able to use various bandwidths.[45] And it is hoped that the development of

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[42] Army Training and Doctrine Command, *2000, Army Satellite Communications Architecture Book*, April 2000, pp. 6.3-6.4, <http://www.army.mil/disc4/references/other.html> [April 7, 2001].

[43] *Ibid.*, p. 6.4.

[44] Communications satellites operate in three basic orbits: Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geosynchronous Orbit (GSO). A satellite, like Globalstar and Iridium, in a LEO generally operate between 400 to 1600 miles above the earth's surface in a polar orbit. Most low earth orbits are nearly circular and require frequent propulsion to keep them at the proper altitude. Since a LEO satellite rotates around the earth and consequently, is only in view from any given point for a short period of time before it passes quickly out of view. Because of this, LEO systems require substantially more satellites to provide continuous services anywhere in the world. MEO satellites commonly operate between 930 and 6800 miles above the earth. Since they are in a higher orbit, fewer satellites (10 satellites) are required to provide worldwide communications coverage. A major disadvantage of MEO satellites is that they cover a lot of empty spaces such as oceans. A GSO satellite operates in at approximately 22,300 miles above the earth and as a result, completes an orbit in the same 24-hour period as the earth's rotation. Additionally, these orbits are in an incline in relation to the equator so there ground trace will be a figure eight over the equator. A satellite with a zero degree incline, directly over the equator is called a geostationary orbit (GEO), a special type of GSO. In this case, the satellite's position remains relatively constant with respect to the earth below it. Only three GSO or GEO satellites are needed to provide communications around the globe; however, Intelsat uses 19 satellites to provide more effective ground coverage and reliability around the entire earth. Information obtained from Army Training and Doctrine Command, pp 1.12–1.14.

[45] Commercial communications satellites systems pass information using radio frequencies within an allocated frequency band. A frequency band is radio frequencies with similar characteristics such as VHF (Very High Frequency) or UHF (Ultra High Frequency). The table below lists the frequency bands and typical usage:

common satellite platforms for various telecommunications services will create economic efficiencies that reduce the overall cost of new systems.

The typical approach is to group satellite communication services into, three general categories of services: fixed satellite services (FSS), mobile satellite services (MSS), and broadcast satellite services (BSS). FSS involves sending and transmitting satellite signals to fixed locations, which can support most commercial applications. Typically, FSS systems provide leased satellite broadcasting to media broadcasters, corporations, telephone companies, and Internet service providers. Today, Intelsat is the largest FSS system in operation. Mobile satellite services (MSS) use various transportable receiver/transmitter units to provide communication services for land mobile, maritime, and aeronautical customers, of which International Mobile Satellite Organization (INMARSAT) was created to provide communication services to maritime users. The third type, BSS, uses small, low cost, receive-only terminals that can be either fixed or mobile. So that services are available to any receiver within a covered area, BSS operates in designated frequencies with high power signals.[46]

Approximate Frequency Band	**Band**	**Typical Usage**
30 – 300 Megahertz (Mhz)	VHF	Messaging, little LEO
0.3 - 3 Gigahertz (Ghz)	UHF	Messaging, little LEO
1 – 2 Ghz	L	Telephony, LEO
2 – 4 Ghz	S	Telephony, MEO
12 – 18 Ghz	Ku	Broadband
27 – 40 Ghz	Ka	Broadband

Information obtained from Army Training and Doctrine Command, pp. 1.21–1.25.

[46] Hughes Space and Communications Company web page, <http://www.hughesglobal.com/satsom.htm> [April 7, 2001].

Tables 1 and 2 list the providers that provide current and future U.S. satellite communications narrowband (low data rate) and broad/wide band (high data rate).[47] These tables outline the capabilities, costs, and anticipated operational timeframes for service. Some of these systems provide global coverage with numerous satellites, while others offer limited coverage for, say, one geographic region. The commercial firms Cyberstar, Spaceway, Astrolink, Teledesic, and Skybridge provide the worldwide, two-way, broadband capability that meets the needs for voice, data, interactive multimedia, and video teleconferencing services in the GEO and LEO regions.[48]

Another area that is expanding rapidly includes the low-earth orbit communications satellites that provide inexpensive, worldwide personal-communications service. This segment of the market is characterized by extremely fierce competition between U.S. and foreign firms. The U.S. firms that compete in this market include Iridium, Globalstar, Ecco, Ellipso, Orbcomm, Gemnet, FaiSat, and Starsys, while the primarily foreign-owned firms include ICO Global (a 79-nation consortium), Signal (a Russian firm), Euro-African Sat Telecom (Matra-Marconi), Eco 8 (Telebras-Brazil), Elekon (Russia/Germany), Gonets-D (Russia), Iris (Belgium), and Leo One (Mexico).[49]

Military Uses of Commercial SATCOM

Communications satellites are critical to U.S. military operations in peacetime as well as war because these systems vastly enhance military effectiveness. At present, the U.S. military is more dependent on commercial SATCOM services than at any time in the past, in

[47] Once again, it is important to note that Tables 1 and 2 were a snapshot in time. The market is shifting and appears to be moving to a conglomeration of both narrowband and wideband.
[48] Thomas S. Moorman, "The Explosion of Commercial Space and the Implications for National Security," *Airpower Journal*, Spring 1999, pp. 10-12. See also Foley, pp. 44-47.
[49] Moorman, pp. 11-12.

Table 1
Emerging Commercial Wideband Satellite Systems

	CYBERSTAR	*ASTROLINK*	*TELEDESIC*	*SPACEWAY*	*SKYBRIDGE*
Major Backers & System Website	LORAL with ALCATEL *(www.cyberstar.com)*	LOCKHEED, Telespazio, and TRW *(www.astrolink.com)*	CRAIG McCAW, BILL GATES, MOTOROLA, SAUDI PRINCE ALWALEED BIN TALAL, & BOEING *(www.teledesic.com)*	GM-HUGHES (www.hns.com /spaceway)	ALCATEL with LORAL *(www.skybridge satellite.com)*
Use	Data, Video	Data, Video, Rural Telephony	Voice, Data, Video Conferencing	Data, Multimedia	Voice, Data, Video Conferencing
Altitude (miles)	22,300 (GEO orbit)	22,300 (GEO orbit)	854 (LEO orbits)	22,300 (GEO orbit)	911 (LEO orbits)
Coverage Area	North America, Asia, Europe	Four major-population landmass regions, covered by five orbital locations	Global	Four major-population landmass regions, covered by eight orbital locations	Global between 68N to 68S
Spectrum	Ku (Initial) And Ka bands	Ka band	Ka band	Ka band	Ku band
Antenna Size (estimated)	16 Inches (Initial Ku)	33-47 Inches	10 Inches	As small as 26 Inches	TBD
Data Throughput	400 kbps (Initial Ku); up to 30 Mbps (Ka)	Up to 9.6 Mbps	Broadband terminals: up to 64 Mbps two-way. Most users: up to 64 Mbps downlink & up to 2 Mbps uplink	Up to 6 Mbps	16 kbps-2Mbps to satellite; 16 kbps-60 Mbps to user
Access Method	FDMA, TDMA	FDMA, TDMA	MF-TDMA, TDMA	FDMA, TDMA	CDMA, TDMA, FDMA, WDMA
Intersatellite Communication)	Undecided	Yes	Yes	Yes	No
User Terminal Cost (estimated)	$800 (Initial Ku); $1000 (Ka)	Under $1000 to $2500	N/A	Under $1000	$700
Operation Starts	2001	2003	2002	2002	2001
Number of Satellites + Spares	TBD for Ku; 3 likely for Ka	9	288	8 initially	80

Source: Army Training and Doctrine Command, pp. 6.22.

Table 2
Emerging Commercial Narrowband
Personal Communications Services (PCS) Satellite Systems

	ELLIPSO	ICO	GLOBALSTAR	ORBCOMM	IRIDIUM
Major Backers & System Website	HARRIS, LOCKHEED-MARTIN, BOEING (*www.ellipso.com*)	ICO-TELEDESIC GLOBAL LTD. (Craig McCaw) (*www.ico.com*)	LORAL, QUALCOMM, ALCATEL (*www.globalstar.com*)	ORBITAL SCIENCES, TELEGLOBE (*www.orbcomm.com*)	IRIDIUM SATELLITE LLC (*www.iridium.com*)
Use	Voice, Fax, Messaging, Paging, Geolocation	Voice and Messaging	Voice, Data, and Fax	Two-way Messaging and Asset Tracking	Voice, Data, Fax, and Paging
Altitude (miles)	Elliptical MEO & Circular MEO orbits	6459 (MEO orbit)	884 (LEO orbit)	500-600 (LEO orbit)	483 (LEO orbit)
Coverage Area	Global north of 50S	Global	Global between 70N to 70S	Global	Global
Spectrum	UHF band	S and C bands	L, S, and C bands	VHF band	L, K, and Ka bands
Data Throughput	Up to 9.6 kbps	2.4 kbps voice; up to 64 kbps data	Up to 9.6 kbps	57.6 kbps	2.4 kbps
Access Method	CDMA	TDMA	CDMA	Packet, X.400 Addressing	FDMA/TDMA
Intersatellite Communication)	No	No	No	No	Yes (K-band)
User Terminal Cost (estimated)	Voice terminals: $1500, fixed station $700, mobile	Voice terminals: $400-$700	Voice terminals: $750	Voice terminals: Starting at $500	Voice terminals: $1000
Operation Starts	2001	2002	November 1999	1995	November 1998
Number of Satellites + Spares	Elliptical MEO: 10 Circular MEO: 7 + replenish by new launches	10 + 2 (Two planes of 5 + 1 at 45 degrees inclination)	48 + 4	35	67 (67 operational as of 20 Aug 1998)

Source: Army Training and Doctrine Command, p. 6.21.

part due to declining defense budgets and the increasing demand for information. U.S. expeditionary forces are going to be quite reliant on SATCOM for the foreseeable future because military forces tend to operate in remote locations and require high-data rate communications well before a terrestrial communications infrastructure can be built.[50] The

[50] Some have argued that the military is relying too much on satellite communications and they should be looking for other solutions. For instance, thanks to revolutionary advances in fiber optic technology, the capacity of a single undersea cable system (640 gigabytes) now exceeds the combined throughput of all the world's 200 commercial communications satellites (260 gigabytes). Yet no worldwide voice or data network is complete without satellites. That is why it is important to have the right mix. In its news report, International

Chairman of the Joint Chiefs of Staff, who specifically identified "information superiority" as essential to military forces in future wars, outlined the doctrinal foundation for information in Joint Vision 2020.[51] In fact, the existing capacity for data transmission vastly exceeds the capacity of existing military satellite systems.[52] For example, an aircraft carrier has sufficient SATCOM capability to generate 300 times more demand on communication satellites than was the case during Operation Desert Storm in 1991.[53] By the year 2010, the J-6 Directorate of the Joint Staff estimates that the satellite bandwidth needs of the U.S.

Bandwidth 2001, TeleGeography <http://www.telegeography.com> estimates that almost half of the world's countries remain dependent on satellites for international connectivity. "Satellites and fiber play complementary roles in international networks. Fiber offers network builders practically unlimited bandwidth, but limited geographic reach, while satellites can provide limited bandwidth, but essentially limitless reach."

[51] Chairman, Joint Chiefs of Staff, *Joint Vision 2020.*

[52] Dedicated, secure, and worldwide military communications services are provided by the Military Satellite Communications (MILSATCOM) architecture. This architecture currently consists primarily of four systems: the Defense Satellite Communications System (DSCS), the Fleet Satellite Communications (FLTSAT) System, the Air Force Satellite Communications (AFSATCOM) System, and the Milstar System. These systems are sustained by the military and were designed to be very reliable, jam-resistance, and survivable.

[53] See Colonel David Anhalt, OSD Office of Net Assessment, *The Decline of the Commercial SATCOM ERA and Its Impact on U.S. Military Advantage*, March 1, 2000, which highlights how SATCOM requirements have increased within the U.S. Navy:

Vietnam era standard was	75 baud TTY
1991 Naval SATCOM standard was	9.6 kilobytes (Kbps)
1993 Naval SATCOM standard was	64 Kbps
1995 Naval SATCOM standard was	500 Kbps
1997 Naval SATCOM standard was	2,000 Kbps
2000 Naval SATCOM standard is	3,000 Kbps
2006 Naval SATCOM requirement is	11,000+ Kbps
2010 Naval SATCOM requirement is	16,000+ Kbps

See also Department of Defense, *Advanced Military Satellite Communications Capstone Requirements Document* (Colorado Springs, CO; U.S. Space Command, April 24, 1998), p. 1.11, which notes that, "The rapid pace of advancements in more capable and more affordable commercial SATCOM technology, occurring independent of military needs, is offering new, even revolutionary, capabilities that can be exploited to meet the warfighters' and their supporting activities rapidly growing information needs. These new capabilities combined with innovative acquisition and leasing strategies, have caused the DoD to rethink how it acquires, uses, and manages commercial resources."

military will be 15 gigabytes per second to support two simultaneous major theater wars. This represents a 150 times growth in required bandwidth over the 100 megabytes per second used during the peak of Desert Storm back in 1991. Since Operation Desert Storm, the U.S. military satellite communications bandwidth has not grown more than 10 percent.[54]

As a result of the Commercial Satellite Communications Initiative (CSCI), the DoD is seeking to improve both fiscally and operationally how it uses commercial capabilities.[55] This program, which is managed by DISA to maximize savings, involves a "one-stop SATCOM shop" for leasing transponder services on commercial satellites to provide teleport services at key locations and the equipment and bandwidth needed for end-to-end transmission services.[56] For example, in Bosnia three different satellites, each with transponders dedicated to military traffic, were contracted to provide two-way wideband connectivity for headquarters command and control as well as point-to-point communications and direct broadcast service.[57] Although this program encourages using commercial SATCOM when operationally and fiscally practical, the DoD has embraced this concept slowly, as noted in the 1998 DoD report, *Impediments to the Innovative Acquisition of*

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[54] *Ibid.*

[55] "In 1995, the Commercial Satellite Communications Initiative (CSCI) Program was established under DISA to provide an easy path for the use of commercial communications by the military services. As of mid 1999, DISA had 18 commercial transponders active worldwide in C- and Ku- band for the expected annual cost of approximately $64M." Source: Headquarters Air Force Space Command, p. 3.47.

[56] Army Training and Doctrine Command, pp. 6.7–6.8.

[57] Pamela Houghtaling, "Agencies Eye Commercial Birds as Interest in Satellite Grows," November 11, 1996. <http://208.201.97.5/pubs/fcw/1111/feat.htm> [April 4, 2001]. See also Space Commission, *Report of the Commission to Assess United States National Security Space Management and Organization*, January 11, 2001, p. 74, cites other examples: In 1995, the U.S. Navy bought more than two million minutes of service on an intergovernmental satellite system constellation, and many Navy ships communicate through the system today. In addition, the U.S. government has leveraged commercially developed direct broadcast satellite technology for its Global Broadcast Service.

Commercial Satellite Communications: Final Report to Congress.[58] Similar concerns were expressed by the U.S. Army's Training and Doctrine Command's *2000, Army Satellite Communications Architecture Book.*[59]

A reasonable assessment, however, is that commercial satellite communication provides an essential service for the U.S. military, whose operational requirements cannot be satisfied without using both commercial and military SATCOM (see Figure 1). More importantly, there is evidence that leasing or purchasing satellite communications services is providing faster and more technologically advanced capabilities and services than government acquisition system can generate.[60] However, the ability to place greater reliance on commercial satellites will depend on the development of acceptable policies and directives.

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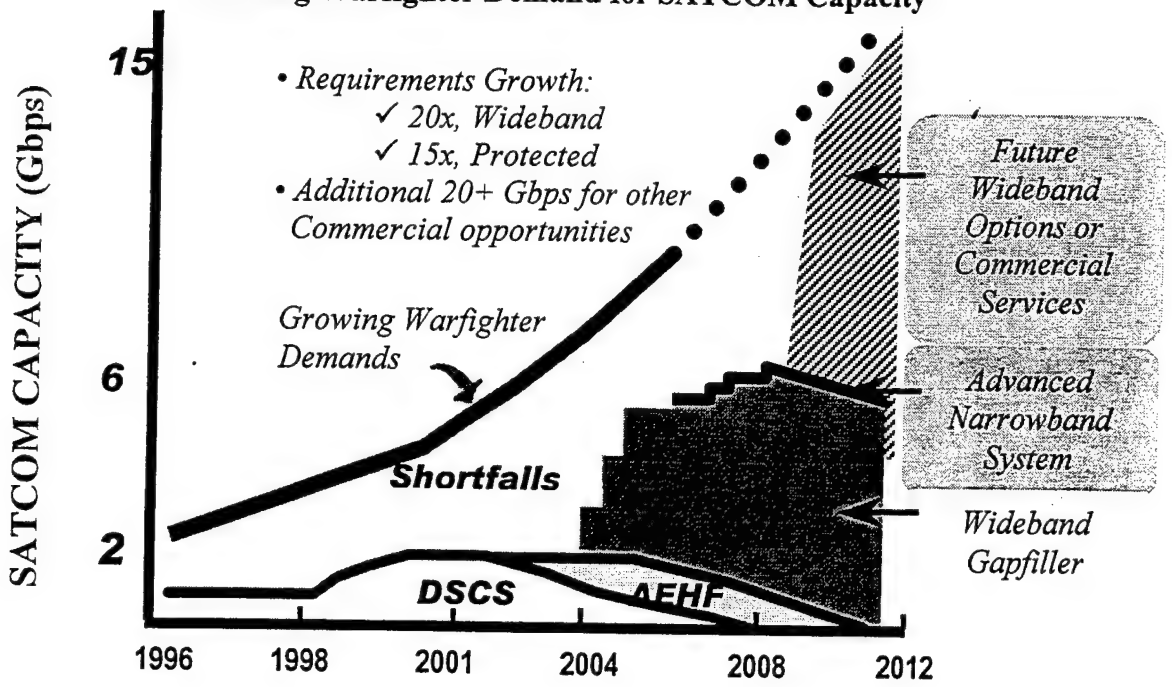
[58] Office of the Under Secretary of Defense, *Department of Defense Report to Congress on Impediments for the Innovative Acquisition of Commercial Satellite Communications*, June 1998, p. 23, states, "The DoD desires commercial systems to provide some level of protection against enemy action, assured, worldwide access for commercial services, U.S. operational control, and system interoperability. While commercial systems are moving towards satisfying some unique DoD requirements such as mobile communications, many military requirements are not being addressed. There should be no expectation of tremendous new business for companies whose product does not address military requirements. Under current policy and direction, DoD will use the commercial satellite market "in more than an augmentation role" when the commercial sector meets DoD performance requirements and is cost-effective."

[59] U.S. Army Training and Doctrine Command, pp. 6.2–6.4. These included: "Using commercial SATCOM requires that military users must compete with civilians for access and those civilians may be our adversaries. There is limited, if any, pre-emption for warfighters against other paying customers. Commercial satellites are not currently built to the same standards as military systems. Although some jam resistance is obtainable, commercial SATCOM systems lack the beam nulling and signal processing capabilities that give military systems the definite edge in extensive jamming environment. Although SATCOM systems have costs associated with their use, it is transparent to the military user who does not see a "bill" for services rendered over the DoD MILSATCOM systems. In addition, landing rights must be negotiated and paid to countries where SATCOM will be used by the U.S. forces."

[60] U.S. Army Training and Doctrine Command, p. 6.2.

Figure 1
Growing Warfighter Demand for SATCOM Capacity[61]



Commercial Satellite Remote Sensing

The area of commercial space activity that is gaining greater attention in the national security establishment is satellite remote sensing.[62] The U.S. program for remote sensing originated in the desire to gain information about the Soviet Union during the Cold War, and by the early 1990s the military, intelligence, civil, and academic communities were the primary users of tightly controlled space imagery.[63]

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[61] Headquarters Air Force Space Command, p. 3.45.

[62] Satellite remote sensing is defined as earth observing systems. It "is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information." Information obtained from CCRS Remote Sensing Tutorial web page <http://www.ccrs.nrcan.gc.ca/ccrs/eduref/tutorial/indexe.html> [April 10, 2001].

[63] Richard C. Doerer, *National Security Implications of the Commercialization of Space* (Carlisle Barracks, PA: Army War College, April 10, 2000), p. 8.

However, this condition changed radically when President Clinton issued Presidential Decision Directive 23 on March 10, 1994, which gave U.S. companies permission to acquire and market the high-resolution satellite imagery that had previously been controlled by government organizations.[64] As importantly, this directive encouraged U.S. satellite firms to compete with foreign firms in the potentially booming market for space imaging.[65] While the commercial remote sensing industry is still quite immature in comparison with commercial satellite communications, it nevertheless is a rapidly growing space market because commercial firms have learned that space imagery is an extremely valuable commodity. At present, several U.S. companies operate satellites and approximately one dozen commercial remote sensing satellite constellations are projected to be operational within the next decade.[66]

For background, there are several major U.S. commercial remote sensing satellite firms, including EarthWatch, Space Imaging, and Orbital Imaging (see Table 3 for information on the imagery provided, resolution, and operational dates). There are several international systems in operation, including SPOT (France), RADARSAT (Canada), IRS (India), ALOS (Japan), CBERS (China/Brazil), and EROS (Israel). The revenues from space imaging are expected to grow from $350 million in 1997 to $6.5 billion in the first decade of the twenty-first century,[67] and more than one dozen countries are expected to possess this capability.[68]

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[64] Hewish, p. 46.
[65] Doerer, p. 9.
[66] *Ibid.*, p. 10.
[67] Hewish, p. 46.
[68] Doerer, p. 9. See also Moorman, p. 16. According to Moorman, "The market is in its infancy but has huge potential. Remote sensing will become an essential part of the information revolution. Images on demand, including three-dimensional products linked to

Table 3
U.S. Commercial Remote Sensing Satellites[69]

System	Spatial Resolution	Revisit Time	Swath Width (at nadir)	Orbit Type	Operational Dates
Space Imaging **IKONOS**	1 meter PAN 4 meter XS	3 days	13 km	Sun synchronous	Sep 1999
OrbImage **ORBVIEW 3**	1 meter Pan 4 meter XS	3 days	8 km	470 km Sun synchronous	Expected late 2001
OrbImage **ORBVIEW 4**	1 meter PAN 4 meter XS 8 meter HYP	3 days	8 km	470 km Sun synchronous	Expected mid 2001
Earthwatch **QUICKBIRD**	.61 cm Pan 2.5 meter XS	1-4 days depending on altitude	17 km	450 km Sun synchronous	Oct 2001

PAN - panchromatic, XS - multispectral, HYP - hyperspectral

There are four types of imagery that are available commercially -- panchromatic, multispectral, hyperspectral, and radar imaging.[70] Functionally, space imaging is used for

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the databases of other geographic information systems and mensurated and indexed through GPS, will become the order of the day. The only question is not whether this will happen but when. I am inclined to believe that the pacing factor will be distribution systems, with their efficiency driven by communications bandwidth and computing power. Although I certainly can't predict the rate of growth, I am inclined to see the utility of remote sensing in the context of the movie *Field of Dreams*—build the systems, and they will come."

[69] TEC Imagery Office (TIO), Topographic Engineering Center, <http://www.tec.army.mil/tio/index.html> [April 12, 2001].

[70] The types of imagery include:

Panchromatic: images displayed as a grayscale image (i.e., black and white) based on the visible part of the spectrum that are best for discriminating objects requiring higher levels of spatial resolution.

Multispectral: multiple images of a scene or object are created using light from different parts of the spectrum (ultraviolet, visible, and infrared portions of the spectrum) that can highlight spectral differences among the surface objects that indicate their composition, such as the nature and health of vegetation.

Hyperspectral: similar to multispectral images except hyperspectral creates a larger number of images from contiguous, rather than disjointed, regions of the spectrum, typically, with much finer resolution. This additional information provides even more detailed data that can be used for specifically identifying natural features, distinguishing camouflage from natural

mapping, agriculture, route planning, urban planning, environmental and resource monitoring, landing planning, oil and gas exploration, and increasingly national security needs.

Military Uses of Commercial Satellite Remote Sensing

The NRO was established in 1961 to manage the development and operation of U.S. reconnaissance satellites. Today, this once highly secret organization, in addition to the National Imaging and Mapping Agency (NIMA), relies increasingly on commercial imaging.[71] During the Persian Gulf War, the U.S. Air Force was the single largest consumer of commercial satellite imagery.[72] While the end of the Cold War signaled a turning point in commercial investments in space, the Persian Gulf War demonstrated to the military that space technology could be vital to the conduct of military operations.[73] This point was evident in the DoD's *Conduct of the Persian Gulf Conflict: Final Report to Congress*.[74]

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vegetation, detecting chemical or biological weapons, or even assessing bomb damage of underground structures.
Radar Imaging: imaging produced by active imaging system that beams pulses of electromagnetic radiation in the microwave region against objects and then records their return signals to generate the final radar image. Radar has the added advantage of allowing the collection of imagery data despite cloud cover, adverse weather, or nighttime.
Information obtained from: <http://www.fas.org/irp/imint/hyper.htm> [April 14, 2001].
See also John C. Baker, Ray A. Williamson, and Bret Johnson, *Security Interests and Dual-Purpose Satellite Technologies: Framing the Policy Issues* (Washington, D.C.: Preliminary Draft Dual-Purpose Space Technologies Project, Space Policy Institute, January 2000).

[71] Doerer, p. 9.

[72] "DoD Learns Wartime Satellite Lessons," *Military Space*, July 29, 1991, p. 5.

[73] Peters.

[74] Department of Defense, *Conduct of the Persian Gulf War: Final Report to Congress*, April 1992, Appendix C, pp. C.18–C.19. "Tactical commanders considered intelligence support at the division, wing, and lower levels insufficient, because of over reliance on national and theater systems, lack of adequate tactical imagery systems, and limited imagery production. Although better dissemination of national and theater intelligence can meet some intelligence requirements, commanders need more and better organic assets."

Today, the needs of the U.S. military vastly exceed the ability of the government to provide satellite imagery with its existing systems, which suggests that the military will gradually increase its reliance on commercial systems, including those owned by foreign firms and governments.[75] To compensate for critical gaps in imagery, as of March 1999 the NRO and NIMA planned to spend more than $1 billion over the next five years to buy satellite imagery from Earthwatch, Orbital Imaging, and Space Imaging.[76] Some of this data will be used by NIMA to generate three-dimensional digital elevation maps for such applications as mission planning and rehearsal.[77]

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[75] Katherine McIntire Peters, "Military Depends on Civilian Satellites," *Government Executive*, April 1, 1998. <http://www.govexec.com/features/0498s1s1.htm> [April 12, 2001].

[76] Hewish, p. 46.

[77] *Ibid.* Topographic Engineering Center, <http://www.tec.army.mil/tio/miluse.htm> [April 12, 2001] identified other military applications of satellite imagery including production of operations plans, map and chart updates, image perspective transformations, and counter-narcotics activities. Selected military applications include:

> *Beach and landing zone analysis* – Determination of terrain, slope, soil, and foliage in support of aircraft operations, ground equipment use, personnel/equipment movement, and amphibious operations.
> *Broad area search* – Systematic examination of broad area imagery covering large areas of land and/or ocean.
> *Camouflage, concealment, and deception detection* – Identification of manmade or natural materials used to cover or conceal activity, or disguise its purpose or identification.
> *Change detection* – Determination of changes in a scene imaged at various times.
> *Damage assessment* – Evaluation of effects of nuclear and conventional weapons, as well as consequences of natural occurrences such as fires and floods.
> *Perspective view* – Presentation of imagery in an oblique perspective by combining it with digital terrain elevation data.
> *Stain, plume, and effluent analysis* – Determination of the changes to soil, vegetation, or manmade objects caused by chemicals, liquids, or gases.
> *Structural analysis* – Determination of composition of manmade objects or protective coverings.
> *Target detection* – Detection of an object or activity by its unique spectral signature, such as vehicle tracks.

While commercial imagery can be ordered from the U.S. Army's Topographic Center and the U.S. Naval Space Command's Remote Earth Sensing Information Center, these commercial systems will not completely replace government systems because they lack the resolution that is necessary for some military applications.[78]

Terrain analysis – Assessment of a geographic area to determine the effect of natural and manmade features on military operations, including cover and concealment, obstacles, key terrain, avenues of approach, and trafficability.
Thermal registration – Discovery and identification of manmade and indigenous activity from patterns of heat distribution.
Trafficability – Determination of the type and characteristics of land and water features over which personnel and equipment will travel.
Watersheds/water analysis – Determination of the bathymetric, thermal, salinity, turbidity or turbulence characteristics of a body of water.

[78] The following provides Sample Ground Resolution Requirements (meters) for Militarily Significant Targets and shows the complementary nature of military and commercial space systems:

TARGET	Detection	General ID	Precise ID	Description	Technical Analysis
Vehicles	1.5	0.6	0.3	0.06	0.045
Radio	3	1	0.3	0.15	0.015
Radar	3	1.5	0.3	0.15	0.015
Command and Control HQ	3	1.5	1	0.15	0.09
Missile Sites (SSM/SAM)	3	1.5	0.6	0.3	0.045
Aircraft	4.5	1.5	1	0.15	0.09
Airfield Facilities	6	4.5	3	0.3	0.15
Bridges	6	4.5	1.5	1	0.3
Troop Units	6	2	1.2	0.3	0.15
Roads	6-9	6	1.8	0.6	0.4
Surface Ships	7.5-1.5	4.5	0.6	0.3	0.045
Coasts, landing beaches	15-30	4.5	3	1.5	0.15
Railroad Yards and shops	15-30	15	6	1.5	0.4
Ports, Harbors	30	15	6	3	0.3
Urban Areas	60	30	3	3	0.75
Terrain Features		90	4.5	1.5	0.75

Increasing government and military reliance on commercial imagery fuels concerns about military access to commercial space systems and their vulnerability in war.[79] The next section discusses the implications of current policies and directives for increasing the use of commercial satellite communications and remote sensing.

Source: Gerald Steinberg, "Dual Use Aspects of Commercial High Resolution Imaging Satellites," *Mideast Security and Policy Studies*, No. 37, February 1998, <http://www.biu.ac.il/SOC/besa/books/37pub.html#VIII> [April 11, 2001].

[79] Moorman, pp. 16-17, who notes, "On the negative side, how does the military deal with adversaries who can access up-to-date imagery benchmarked against GPS on their personal computers through the Internet? Not only will ensuring the element of surprise in military operations be infinitely more difficult, the imagery becomes the targeting database for the rogue nation or terrorist. This is why the Clinton administration has insisted on "shutter control." I don't have a good answer for this dilemma, but the military of the next century must plan its operations with this potential transparency in mind, and it must develop sophisticated countermeasures."

SECTION III

REVIEW OF U.S. POLICY

The commercialization of space systems has grown steadily during the last forty years, and as importantly, an increasing number of countries are entering the market for commercial space systems.[80] This section discusses U.S. and DoD policies that govern the use of commercial satellite communications and remote sensing.[81] In addition to various treaties governing space, there are a number of specific and detailed intergovernmental agreements that establish the legal basis for international space systems and organizations, such as INTELSAT, INMARSAT, ARABSAT, among others.

It is important to understand that U.S. space policies and laws have evolved over decades.[82] Table 4 lists the policies and directives that will be examined and had the greatest influence in the commercial sector.

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[80] There are 38 countries with a total of 2731 satellites in orbit. Source: Air Force Association Space Almanac 2000.
<http://www.afa.org/magazine/space/payloads_orbit.html> [May 8, 2001].

[81] In this study, we use the term "policy" as a broad reference for all of the documents produced by government agencies in the U.S., which includes explicit policy guidance, presidential decision directives, as well as memoranda.

[82] "Long before a satellite was sent into orbit around the earth, many of the legal problems which would be created by this advance in science and technology were anticipated and analyzed. Indeed, the quality and quantity of published articles in this field are a matter of amazement to those who have only recently become aware of the impact of satellite development upon society. It is fortunate that so much fundamental thinking is already in existence at a time when scientific facts are rapidly developing and need to be studied in relation to national and international situations." Source: Space Law: A Symposium, 85th Congress, 2nd Session December 31, 1958, Washington, Government Printing Office, 1959, p. v.

Table 4
Policy Influence on the Commercial Sector

GENERAL	COMMUNICATIONS	REMOTE SENSING
• NASA Act of 1958 • Outer Space Treaty of 1967 • Commercial Space Launch Act of 1984 • U.S. Commercial Space Policy Guidelines, NSPD-3, Feb 11, 1991 • National Space Policy, Sept 19, 1996 • Presidential Decision Directive-63 (PDD-63), 22 May 1998 • Department of Defense Space Policy, DoD Directive 3100.10, 9 Jul 1999 • 1999 Unified Command Plan (UCP), U.S. Space Command • National Information Assurance (IA) Policy for Space Systems, NSTISSP No 12, Jan 2001	• Communications Satellite Act 1962 • International Maritime Satellite Telecommunications Act of 1978 • Communications Satellite Competition and Privatization Act 1998 • Chairman of the Joint Chiefs of Staff Instruction (CJCSI 6250.01), 20 Oct 1998	• Land Remote-Sensing Commercialization Act of 1984 • Land Remote Sensing Policy Act of 1992 • Foreign Access to Remote Sensing Space Capabilities, Mar 10, 1994 (PDD-23) • Commercial Space Act of 1997, Commercial Remote Sensing • MOU Among the Department of State, Defense, Commerce, Interior and the Intelligence Community Concerning the Licensing of Private Remote Sensing Satellite Systems (1999) • Policy Directive for Commercial Affairs, NIMA Letter Dated 1 Mar 2000

GENERAL POLICIES AND DIRECTIVES

National Aeronautics and Space Act (NASA Act) of 1958

In the United States, the first and arguably most important law governing the development and use of space is the NASA Act of 1958.[83] On November 21, 1957, shortly after the Soviet Union launched the Sputnik satellite, the U.S. Rocket and Satellite Panel called for a National Space Establishment that did not depend on direct military

[83] Nandasivi Jasentuliyana, *Space Law, Development and Scope* (Westport, CT: Praeger Press, 1992), p. 71.

appropriations.[84] With this step, the United States established the principle that a civilian agency would play a dominant role in the development of space systems and technologies.

1967 Outer Space Treaty

While the legal regulation of space systems emerged with the beginning of space activities, international laws and regulations governing space have expanded steadily since the signing of the 1967 Outer Space Treaty. Undoubtedly the most important international space convention is the Outer Space Treaty of 1967, which built on several principles that were stated in the Declaration of Legal Principles Governing the Activities of States in the Exploration of Outer Space that was signed in 1963. This Treaty is predicated on the principle of the freedom of exploration and use of outer space, and it includes the ability to freely conduct scientific research and have free access to all celestial bodies. The freedom of exploration and use principle establishes the requirement that the exploration and use of space must be carried out for the benefit of and in the interest of all countries equally, as noted in the Charter of the United Nations which promotes international cooperation and understanding. This treaty, which has been ratified by ninety-one nations, establishes the basic framework for the field of international space law.[85]

The Outer Space Treaty was not expected to remain the sole instrument governing human activities in exploring and using outer space. It was hoped that the basic principles

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[84] *A National Mission to Explore Outer Space: A Proposal of the Rocket and Satellite Research Panel*, November 21, 1957, U.S. Senate, Special Committee on Space and Astronautics, Committee Print, *Compilation of Materials on Space and Astronautics*, No. 1, 85th Congress, 2nd Session., Government Printing Office, March 27, 1958, pp. 14-16. "The National Space Establishment will unify the efforts and contributions of science, industry and military to space research, and will draw the youth of our country into science." For the Declaration of Policy and Purpose of the NASA Act of 1958, see Section 102.

[85] Frank G. Klotz, Space, *Commerce, and National Security* (New York, NY: Council on Foreign Relations, 1998), p. 18.

set forth in the Treaty would gain further elaboration.[86] Despite the emphasis in the Outer Space Treaty on the peaceful use of space, as articulated by the provisions for unimpeded access and noninterference, this legal regime does not rule out the use of space for military purposes. However, the Outer Space Treaty explicitly states that weapons of mass destruction may not be placed in Earth orbit or on celestial bodies.[87] Additionally, it delared that outer space could not be claimed as national territory, thus legitimizing satellite travel over any point on Earth. Despite years of lobbying by the former Soviet bloc and developing countries, who wanted a right of prior consent to review and possibly withhold data about their territories, there is no such provision to date.

National Security Decision Directive No. 42 (NSDD-42), "National Space Policy," July 4, 1982

The Reagan Administration issued a NSDD-8, November 13, 1981 that restated the role of the Space Transportation System in U.S. space activities. Shortly thereafter, under the direction of the Science Adviser George Keyworth, a comprehensive review of space policy began, whose results are contained in NSDD-42 and replaced NSDD-8 and three of the Carter administration space policy statements, NSDD-37, 42, and 54. NSDD-42 also established as the primary forum for space policy formulation the National Security Council Senior Interagency Group (Space)—SIG (Space)—chaired by the Assistant to the President

[86] Jasentuliyana, p. 47.
[87] Treaty on the Principles of the Activity of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies, October 10, 1967, *Treaties and Alliances of the World* (Essex: Longman Group U.K., 1990), p. 40.

for National Security Affairs. SIG (Space) was the focus of policymaking throughout President Reagan's two terms.[88]

Under this directive, the United States shall conduct civil space programs to expand knowledge of the Earth, its environment, the solar system, and the universe; to develop and promote selected civil applications of space technology; to preserve the U.S. leadership in critical aspects of space science, applications, and technology; and to further U.S. domestic and foreign policy objectives.[89] Consistent with the NASA Act, the following policies shall govern the conduct of the space program. One is that the U.S. government will provide a climate conducive to expanded private sector investment and involvement in civil space

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[88] National Security Decision Directive Number 42, "National Space Policy," July 4, 1982. <http://www.hq.nasa.gov/office/pao/History/nsdd-42.html> [March 28, 2001]. The basic goals of U.S. space policy are to: strengthen the security of the United States; maintain United States space leadership; obtain economic and scientific benefits through the exploitation of space-related activities; promote international cooperative activities that are in the national interest; and cooperate with other nations in maintaining the freedom of space for all activities that enhance the security and welfare of mankind. In addition, "The United States space program shall be conducted in accordance with the following basic principles: 1) The United States is committed to the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all mankind; 2) The United States rejects any claims to sovereignty by any nation over outer space or celestial bodies, or any portion thereof, and rejects any limitations on the fundamental right to acquire data from space; 3) The United States considers the space systems of any nation to be national property with the right of passage through the operations in space without interference. Purposeful interference with space systems shall be viewed as infringement upon sovereign rights; 4) The United States encourages domestic commercial exploration of space capabilities, technology, and systems for national security concerns, treaties, and international agreements; 5) The United States will conduct international cooperative space-related activities that achieve sufficient scientific, political, economic, or national security benefits for the nation; 6) [Paragraph deleted in declassification review]; 7) The United States will pursue activities in space in support of its right of self-defense; and 8) The United States will continue to study space arms control options. The United States will consider verifiable and equitable arms control measures that would ban or otherwise limit testing and deployment of specific weapons systems should those measures be compatible with United States national security. The United States will oppose arms control concepts or legal regimes that seek general prohibitions on the military or intelligence use of space."

[89] *Ibid.*, *Civil Space Program*, section
<http:www.hq.nasa.gov/office/pao/History/nssd-42.html> [March 28, 2001].

activities, with due regard to public safety and national security. Private sector space activities will be authorized and supervised by the government to the extent required by treaty and national security. Furthermore, the field of civil operational remote sensing is the responsibility of the Department of Commerce.[90]

Commercial Space Launch Act of 1984

The purpose of the Commercial Space Launch Act of 1984 was to commercialize or privatize space launch services, which were previously dominated by government organizations. The objective was not to completely privatize space launch but to combine government and private sector responsibilities, while encouraging the government to maintain its own launch capabilities.[91] Congress encouraged the private sector to become more involved in launch activities, but simultaneously required the government to do the same. In essence, Congress wanted greater involvement by private enterprise and required the government to regulate space launch services.[92]

An important principle addressed by this Act concerned international law and the right of satellite overflight. In view of the importance of nuclear weapons in international security, the unrestricted ability of imagery satellites to freely overfly sovereign territory was absolutely essential for arms control purposes. Hence, the term "national technical means"

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[90] *Ibid.*, *Civil Operational Remote Sensing* section: The Department of Commerce will: 1) Aggregate Federal needs for civil operational remote sensing to be met by either the private sector or the Federal government; 2) Identify needed civil operational system research and development objectives; and 3) In coordination with other departments or agencies, provide for regulation of private-sector operational remote sensing systems.

[91] *Commercial Space Launch Act of 1984*, Pub. L. No. 98-575, 98 Stat. 3055, 49 U.S.C. App. Sec. 2601, Oct. 30, 1984.

[92] *Ibid.*, According to Section 2 (&), this was done "in order to encourage compliance with international obligations of the United States and to protect the public health and safety, safety of property, and national security interests and foreign policy interests of the United States."

and pledges not to interfere with these systems were enshrined in arms control agreements, such as the Anti-Ballistic Missile (ABM) Treaty.[93]

Presidential Directive on National Space Policy, February 11, 1988

There were a number of significant changes in the Reagan administration's space policy between July 1982 and 1987, of which the Challenger accident in 1986 played an important role. The increased emphasis on commercial uses of space resulted in the new policy statement on January 5, 1988, but its release was withheld until the Economic Policy Council completed a review of commercial space policy initiatives. The primary objective of this review was to consolidate and update Presidential guidance on U.S. space activities well into the future. This directive states that the U. S. government shall not preclude or deter the continuing development of a separate, non-governmental commercial space sector. At the same time, growing private sector investments in space by the commercial sector will have economic benefits for the United States and support governmental space sectors with an increasing range of space goods and services. Commercial sector space activities shall be supervised or regulated only to the extent that is required by law, national security, international obligations, and public safety.[94]

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[93] Todd Black, "Commercial Satellites, Future Threats or Allies?" *Naval War College Review,* Winter 1999.
<http://www.nwc.navy.mil/press/Review/1999/winter/art5-w99.htm> [March 28, 2001]

[94] *Presidential Directive on National Space Policy*, February 11, 1988.
<http://fas.org/spp/military/docops/national/policy88.htm> [March 28, 2001]. See also the *Commercial Space Sector* guidelines: 1) The directive states that NASA, and the Departments of Commerce, Defense, and Transportation will work cooperatively to develop and implement specific measures to foster the growth of private sector commercial use of space. A high-level focus for commercial space issues has been created through establishment of a Commercial Space Working Group of the Economic Policy Council. SIG (Space) will continue to coordinate the development and implementation of national space policy. 2) To stimulate private sector investment, ownership, and operation of space assets,

National Space Policy Directives and Executive Charter, NSPD-1, November 2, 1989

Under NSPD-1, U.S. space activities were conducted by the three separate and distinct sectors of civil, national security, and for the first time, a separate, non-governmental commercial sector. This policy advocated close coordination, cooperation, and technological and information exchanges among these sectors in order to avoid unnecessary duplication and promote U.S. goals.

According to this policy, the U.S. government shall not preclude or deter the continuing development of a separate, non-governmental commercial sector. The governmental space sectors shall purchase commercially available space goods and services to the fullest extent feasible and shall not conduct activities with potential commercial applications that preclude or deter commercial sector space activities except for national security or public safety reasons. Commercial sector space activities shall be supervised or

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and directive provides that the U. S. government will facilitate private sector access to appropriate U.S. space-related hardware and facilities, and encourage the private sector to undertake commercial space ventures. The directive states that government space sectors shall, without providing direct Federal subsidies: a) Utilize commercially available goods and services to the fullest extent feasible, and avoid actions that may preclude or deter commercial space sector activities except as required by national security or public safety; b) Enter into appropriate cooperative agreements to encourage and advance private sector basic research, development, and operations while protecting the commercial value of the intellectual property developed; c) Provide for the use of appropriate government facilities on a reimbursable basis; d) Identify, and eliminate or propose for elimination, applicable portions of United States laws and regulations that unnecessarily impede commercial space sector activities; e) Encourage free trade in commercial space activities. The United States Trade Representative will consult, or, as appropriate, negotiate with other countries to encourage free trade in commercial space activities; f) Provide for the timely transfer of government-developed space technology to the private sector in such a manner as to protect its commercial value, consistent with national security; and g) Price government-provided goods and services consistent with OMB Circular A-25. 3) The directive also states that the DoC will commission a study to provide information for future policy and program decisions on options for a commercial advanced earth remote sensing system.

regulated only to the extent required by law, national security, international obligations, and public safety.[95]

U.S. Commercial Space Policy Guidelines, NSPD-3, February 11, 1991

In view of the role of commercial space launch, Congress established guidelines governing commercial space systems that encourage the commercial use and exploitation of space technologies and systems for economic and technological purposes. The intention was to encourage commercial activities that are consistent with U.S. national security and foreign policy interests, international and domestic legal obligations, and the requirements of government agencies. The theory behind this policy, which articulates the principle that the United States will pursue commercial space objectives without direct federal subsidies, is that a robust commercial space sector could generate new technologies, products, markets, jobs, and economic benefits for the nation as well as generate indirect benefits for national security. These guidelines were designed to help private sector firms by establishing stable and predictable policies for dealing with the U.S. government. More broadly, these guidelines were written to encourage the growth of the U.S. commercial space sector so that the government would be able to use commercially available space products and services to the maximum possible extent.

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[95] *National Space Policy Directive-1*, November 2, 1989, <http://www.fas.org/spp/military/docops/national/nspd1.htm> [March 28, 2001]. The Intersector policies section states: "A continuing capability to remotely sense the Earth from space is important to the achievement of United States space goals. To ensure that the necessary capability exists, the United States government will: 1) Ensure the continuity of Landsat type remote sensing data; 2) Discuss remote sensing issues and activities with foreign governments operating or regulating the private operation of remote sensing systems; 3) Continue government research and development for future advanced remote sensing technologies or systems; and 4) Encourage the development of commercial systems, which image the Earth from space, competitive with, or superior to, foreign operated civil or commercial systems."

National Space Policy, 14 September 1996

An important part of U.S. national space policy was to encourage the use of commercial space systems. Signed on September 14, 1996, the U.S. space policy was designed to provide the framework for greater cooperation in and focus on space programs for civil, commercial, intelligence, and military organizations. The rationale was that it is essential for the United States to have clear strategies and policies that integrate military policy and doctrine for all aspects of military operations.

The U.S. space policy was designed to address five specific goals of the U.S. space program as well as to provide guidelines for the areas of civil, national security, commercial, and intersector uses of space.[96] In addition, U.S. space policy states that the United States is committed to the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all humanity.[97] The phrase "peaceful purposes" allows defense and intelligence-related organizations to operate space in ways that are consistent with national security policy and interests.[98]

Civil Space Guidelines. The U.S. President gave NASA the authority to act as the lead agency for conducting research and development in all areas pertaining to civil space. According to those guidelines, NASA in coordination with other departments and agencies

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[96] *National Space Policy, September 14, 1996*, states the goals of the U.S. space program are to "(a) Enhance knowledge of the Earth, the solar system and the universe through human and robotic exploration; (b) Strengthen and maintain the national security of the United States; (c) Enhance the economic competitiveness, and scientific and technical capabilities of the United States; (d) Encourage State, local and private sector investment in, and use of, space technologies; (e) Promote international cooperation to further U.S. domestic, national security, and foreign policies." These goals are in agreement with policies from lower levels.
[97] Executive Office of the President, *Clinton Administration Accomplishments in Space: A Final Report to the President of U.S. Activities in Space*, January 2001, p. 31.
[98] *Ibid.*, p. 31.

will focus its research and development efforts in order to develop new space technologies and applications that support U.S. economic interests and government policies. Accordingly, NASA seeks to privatize or commercialize its space communications operations no later than 2005.[99] The Department of Commerce, in conjunction with the National Oceanic and Atmospheric Administration (NOAA), has the principal responsibility for managing the earth observations that are necessary to meet civil requirements. The DoC is responsible for regulating and licensing the operation of private sector remote sensing systems.[100]

National Security Space Guidelines. Those space activites that are necessary to protect U.S. national security will be overseen by the Secretary of Defense and the Director of Central Intelligence (DCI). Their key national security priorities are to improve the U.S. ability to support global military operations, monitor and respond to strategic military threats, and monitor arms control and non-proliferation agreements. The Secretary of Defense and DCI will continue to modernize their capabilities of their respective activities to collect intelligence information in the presence of changing threats, environments, and adversaries.[101] These guidelines also establish that DoD's role is to maintain the capability for space support, force enhancement, space control, and force application.[102] In addition, it

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[99] *Ibid.*, p. 33.
[100] *Ibid.*, pp. 33-34.
[101] *Ibid.*, p. 34.
[102] These functions are defined as follows: "*Space Support* functions are those required to deploy and maintain military equipment and personnel in space. They include activities such as launching and deploying satellites, maintaining and sustaining space vehicles while in orbit, and recovering space vehicles, if required. In order to do this DoD should emphasize robust satellite control. This may include autonomous satellite operations, survivable command links, and mobile ground controlling stations. Also, DoD should have assured access to space through a mix of launch systems, make payloads compatible with more than one launch system when possible, facilitate commercial space capabilities, and pursue new systems, especially launch-related concepts. *Force Enhancement* includes those space-related support operations conducted to improve the effectiveness of both terrestrial and

is incumbent on the Secretary of Defense to establish the Department's requirements for military and national-level intelligence information and satellite control.[103] The DoD is also expected to operate and maintain the space control capabilities that are necessary to ensuring freedom of action in space and, if directed, to deny that freedom of action to U.S. adversaries. Finally, those guidelines state that the United States will pursue a program for ballistic missile defense in order to enhance U.S. capabilities against theater missiles, to hedge against the emergence of a ballistic missile threat to the United States, and to provide technological options for missile defenses.[104]

Commercial Space Guidelines. The goal of U.S. commercial space policy is to support and enhance U.S. economic competitiveness in space activities, while protecting U.S. national security and foreign policy interests. According to these guidelines, expanding U.S. commercial space activities will have economic benefits for the nation as well as increase the range of space goods and services that are available to the government. In practice, the intent is for the U.S. government to purchase commercial space goods and services, and to abstain from activities that preclude or deter commercial firms from producing such services and products, except for reasons of national security or safety. For these guidelines, "commercially available" is defined as a space good or service that is currently offered

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space based forces. Force enhancement includes such capabilities as communications, navigation, and surveillance. Also, civil/commercial/allied capabilities may augment DoD systems to support military space force enhancement requirements, particularly if primary DoD capabilities were to be lost. *Space Control* consists of operations that ensure freedom of action in space for friendly forces while limiting or denying enemy freedom of action. It includes satellite negation and satellite protection. *Force Applications* involves the conduct of combat operations from space." *Army Space Reference Text, Chapter 3 - Space Policy and Law*, http://www.fas.org/spp/military/docops/army/ref_text/chap3im.htm> [March 28, 2001].

[103] Executive Office of the President, p. 5.

[104] *Ibid.*, p. 6.

commercially or that could be supplied commercially in response to a government request for service. Furthermore, these guidelines state that the ability to stimulate private sector investment, ownership, and operation of space assets will require the government to promote a climate which helps commercial firms gain access to appropriate space related hardware, facilities, and data.[105]

Intersector Guidelines. These guidelines mandate that enhanced cooperation between the intelligence, civil, and commercial space sectors is necessary to ensure that all organizations in the space sector benefit from space technologies, facilities, and support services. In terms of international cooperation among civil space activities, NASA is tasked to ensure that communications and control facilities for civil research spacecraft are interoperable by working with foreign space agencies and international organizations.[106]

Department of Defense Space Policy Directive 3100.10 (July 9, 1999)

The Department of Defense Directive 3100.10 on Space Policy has undergone significant updates since the last major changes that occurred toward the end of the Cold War. These changes were necessary because space activities are increasingly essential to achieve U.S. national security objectives and to maintain the nation's technological leadership in space.[107]

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[105] *Ibid.*, pp. 7-8.
[106] *Ibid.*, p. 9.
[107] See *Department of Defense Space Policy*, July 9, 1999, which, "Incorporates new policies and guidance promulgated since the last update. Addresses the major changes since the last update which includes: transformation of the international security environment; promulgation of new national security and national military strategies; changes in the resources allocated to national defense; changes in force structure; lessons learned from the operational employment of space forces; the global spread of space systems, technology, and information; advances in military and information technologies; the growth of commercial space activities; enhanced intersector cooperation; and increased international cooperation."

The fundamental purpose of DoD policy is to ensure that the nation has access to space for those activities conducted in space that are critical to U.S. security and economic interests. According to this policy, DoD's primary goal for space and space-related activities is to provide operational capabilities that will ensure the ability of the United States to use space to achieve its national security objectives. Other goals include sustaining a robust U.S. space industry and technological superiority. This policy requires the United States to maintain the capabilities that are necessary for space support, force enhancement, and space control, which are sufficiently robust, ready, secure, survivable, resilient, and interoperable to meet the needs of the national command authority, combatant commanders, military services, and intelligence users.[108]

This policy holds that using civil and commercial space capabilities to the maximum extent feasible and practical is consistent with U.S. national security interests. Additionally, an integrated architecture of space and ground communications systems shall be developed to take advantage of defense, intelligence, civil, commercial, allied, and friendly space capabilities. This policy calls for supporting commercial space activities in order to enhance U.S. security, and to use commercial off-the-shelf technologies and systems when possible. For this policy to succeed, it is important to integrate research and development for commercial and government space systems and technologies. Fundamentally, this DoD policy encourages the use of outsourcing or privatization of space-related functions and tasks that could be performed more efficiently and effectively by the private sector. In the area of research and development, this policy directs that the government should use commercial

[108] *Ibid.*, p. 7.

systems and technologies that could be exploited to help industry conduct research and development for new space systems.[109]

DoD space policy identifies the need to use professional military education as well as joint and military training exercises to inform personnel at all levels about space force structure, missions, capabilities, and applications. The ability to operate under foreign surveillance or against an adversary using space capabilities, and the ability to compensate for losses of capability, shall be integrated into appropriate Joint and Services exercises. Additionally, to enhance U.S. space technologies, facilities, and support services, the policy encourages cooperation among intelligence, civil, and commercial space sectors.[110]

1999 Unified Command Plan (UCP), U.S. SPACE COMMAND

Under the 1999 Unified Command Plan (UCP), the U.S. Commander-in-Chief, SPACE (USCINCSPACE) is the focal point for military concerns about space operations, and serves as the military representative to U.S. national agencies, commercial, and international organizations for matters related to space operational matters. USCINCSPACE coordinates with the Joint Staff and the other Commander-in Chiefs (CINCs) to represent the military on space operations with national, commercial, and international agencies, which is particularly important for government agencies when adversaries could use many commercial space systems for military and commercial purposes. Specifically, the military is tasked with guiding how the U.S. government develops multilateral or bilateral agreements on surveillance and warning, expands command and control capabilities among the CINCs,

[109] *Ibid.*, pp. 9-12.
[110] *Ibid.*, p. 13.

renegotiates the ABM and other treaties when those capabilities may be affected, and addresses how the United States will respond to attacks against our space systems.[111]

As force enhancement missions (e.g., terrestrial surveillance and navigation) migrate to space, U.S. Space Command (SPACECOM) will need to define policies for sharing information from civil, commercial, and military means and organizations. If U.S. military forces depend on foreign systems for space-based information, U.S. policy must consider the possibility that access to these sources may be denied. In 1997, the President's Commission on Critical Infrastructure Protection called for a national effort to protect U.S. security at a time when the U.S. infrastructure was becoming increasingly vulnerable.

Presidential Decision Directive-63 (PDD-63), Protecting America's Critical Infrastructures, May 22, 1998

Presidential Decision Directive 63 was written to address concerns about the vulnerability of space systems. This Presidential Directive builds on the recommendations of the President's Commission on Critical Infrastructure Protection, which in October 1997 called for a national effort to assure the security of the United States in the face of growing vulnerabilities in the areas of telecommunications, banking and finance, energy, transportation, and essential government services. PDD-63 was an interagency effort to evaluate recommendations and establish a framework for protecting the infrastructure by using a reliable, interconnected, and secure information system by the year 2003.[112] After

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[111] USSPPACECOM policy, <http://www.spacecom.af.mil/usspace/LRP/ch07a.htm> [March 28, 2001].

[112] PDD-63 sets up a new structure addressing the following: 1) Sets a goal of a reliable, interconnected, and secure information system infrastructure by the year 2003, and significantly increased security to government systems by the year 2000, by immediately establishing a national center to warn of and respond to attacks; ensuring the capability to protect critical infrastructures from intentional acts by 2003; 2) Addresses the cyber and

addressing the nature of vulnerabilities to the infrastructure, U.S. government agencies evaluated the need for information assurance for all U.S. space systems, which resulted in NSTISSP No. 12 dated January 2001.

National Information Assurance (IA) Policy for U.S. Space Systems, National Security Telecommunication and Information Systems Security Committee, NSTISSP No. 12, January 2001.

The primary objective of this policy is to ensure that information assurance is considered in all aspects of U.S. space systems, including planning, design, launch, sustained operation, and deactivation of all U.S. space systems that collect, generate, process, store, display, or transmit national security information. This policy also reminds users outside the national security community that information assurance of space systems is critical to the operation and maintenance of the U.S. infrastructure.[113]

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physical infrastructures of the Federal Government by requiring each department and agency to work to reduce its exposure to new threats; 3) Requires the Federal Government to serve as a model to the rest of the country for how private sector in an infrastructure protection is to be attained; 4) Seeks the voluntary participation of private industry to meet common goals for protecting our critical systems through public/private partnerships; 5) Protects privacy rights and seeks to utilize market forces. It is meant to strengthen and protect the nation's economic power, not to stifle it; 6) Seeks full participation and input from the Congress; 7) A National Coordinator whose scope will include not only a critical infrastructure but also foreign terrorism and threats of domestic mass destruction (including biological weapons) because attacks on the U.S. may not come labeled in neat jurisdictional boxes; 8) A National Infrastructure Protection Center (NIPC) at the FBI, which will fuse representatives from FBI, DoD, U.S. Secret Service (USSS), Energy, Transportation, the Intelligence Community, and the unprecedented attempt at information sharing among agencies in collaboration with the private sector. The NIPC will also provide the principle means of facilitating and coordinating the Federal Government are modeled on the Centers for Disease Control and Prevention (CDC); and 9) The Critical Infrastructure Assurance Office will provide support to the National Coordinator's work with government agencies and the private sector in developing a national plan. The office will also help coordinate a national education and awareness program, and legislative and public affairs.

[113] NSTISSP No. 12, January 2001, p. 1.

This policy was written to highlight the responsiveness of the national security community to the nation's changing information security needs. It applies to all U.S. government or commercially owned and operated space systems, all supporting or related national security systems, and all U.S. departments and agencies that are involved with these systems. It defines the responsibilities of the Director of the National Security Agency as well as heads of U.S. departments and agencies that deal with information assurance. Finally, this policy establishes the requirements for information assurance for U.S. space systems that use cryptographic techniques. The next section discusses the policies and directives that govern the use of commercial satellite communications.

SATELLITE COMMUNICATIONS POLICIES AND DIRECTIVES

Commercial satellite communications, which is the oldest commercial space activity, was recognized as space sector in 1962 with the issuance of the Communication Satellite Act of 1962.

Communications Satellite Act of 1962

Communications satellites, which were developed in the United States with significant government assistance and subsidies, have experienced the greatest degree of commercial success and international cooperation. In 1962, only four years after the NASA Act, the Communications Satellite Act was passed, which established an operational communications satellite system.[114] More importantly, the United States took a global view of how outer space should be used, as seen from the declaration of policy and purpose that

[114] Jasentuliyana, p. 77.

was outlined in Section 102.[115] This act established the Communications Satellite Corporation, COMSAT, which on April 6, 1965 launched its first satellite, *Early Bird*, from Cape Canaveral. It was at this point that the era of global satellite communications began.

Following the establishment of COMSAT, the U.S. government established the International Telecommunications Satellite Consortium (INTELSAT) in 1964 through the Interim Arrangements for a Global Commercial Satellite System.[116] Developments in space technology in combination with the need for international communications created a high degree of international cooperation in space. The U.S. policy that governed this activity remained unchanged until Executive Order 12046, *Relating to the Transfer of Telecommunications Functions* was signed in 1978. This executive order transferred responsibility for aiding, "in the planning and development of the commercial communications satellite system and (aiding) in the execution of a national program for the operation of such a system" to the DoC.[117] In 1998, the Communications Satellite Competition and Privatization Act amended the Communications Satellite Act of 1962 to increase the level of competition and accelerate the pace of privatization in satellite

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[115] *Ibid.* "The Congress hereby declares that it is the policy of the United States to establish, in conjunction and in cooperation with other countries, as expeditiously as practical, a commercial communications satellite system, as part of an improved global communications network, which will be responsive to public needs and national objectives, which will serve the communication needs of the United States and other countries, and which will contribute to world peace and understanding."

[116] For the early history of communications satellites, see Jonathan F. Galloway, *The Politics and Technology of Satellite Communication* (Lexington, MA: Lexington Books, 1972).

[117] White House, Office of the President of the United States, *Executive Order 12046 – Relating to the Transfer of Telecommunication Functions*, March 27, 1978. <http://www.nara.gov/fed/eos/212046.html> [April 10, 2001].

communications.[118] In 1976, COMSAT launched the MARISAT satellite to provide mobile services to the U.S. Navy and other maritime customers.

International Maritime Satellite Telecommunications Act of 1978

To promote maritime satellite communications and to improve communications for distress and maritime safety, the United States passed the International Maritime Satellite Telecommunications (INMARSAT) Act in 1978. This act promoted maritime satellite communications through the International Maritime Satellite Organization, which was established in 1976. The COMSAT Corporation was assigned the role as the "designated entity" to represent the United States on the INMARSAT Council. INMARSAT changed its name in 1998 to "International Mobile Satellite Organization" but retained the name INMARSAT.

Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 6250.01, October 20, 1998

The reason for this instruction was to define the processes that are necessary to ensure that SATCOM will be able to provide critical support for military missions. It also provides the framework for establishing both global and regional SATCOM support centers as well as their integration with DISA's existing global and regional operations centers to provide a integrated communications for military and other users. Additionally, this instruction identifies the user connectivity requirements that are necessary for operational planning, access to current satellite systems (both military and commercial), and planning for future

[118] Jasentuliyana, p. 78, states, < http://www.cmcnyls.edu/public/USLAWS/hr1872eh.htm>, "It is the purpose of this Act to promote a fully competitive global market for satellite communication services for the benefit of consumers and providers of satellite services and equipment by fully privatizing the intergovernmental satellite organizations, INTELSAT and INMARSAT."

communications capabilities. The intent is to promote a joint approach to achieve the most effective use of constrained SATCOM resources and to plan for future systems.[119]

SATELLITE REMOTE SENSING POLICIES AND DIRECTIVES

Information from remote sensing satellites is becoming increasingly important for national security, emergency planning, and regional studies as well as civil engineering, weather forecasting, media coverage, and environmental protection. Since the 1960's, remote sensing from space historically has supported U.S. national security interests, particularly in terms of providing critical information to political and military leaders in crises and war.

In 1972-73, President Nixon established the Federal Mapping Task Force whose function was to consider means for sharing remotely sensed reconnaissance data with civil agencies. A 1973 Office of Management and Budget report recommended greater utilization of remotely sensed data but did not address the issue of the commercialization of space systems. In a program review conducted in 1978 by the Carter Administration, the conclusion was that the commercialization of space systems was not feasible then in view of

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[119] *Chairman of the Joint Chiefs of Staff Instruction* (CJCSI) 6250.01, October 20, 1998, p. 2. This instruction cancels CJCS Memorandum of Policy Number 37, dated May 14, 1992, and the primary changes in this instruction were 1) Establishes an operational management structure with U.S. SPACECOM as the SATCOM Operational Manager (SOM) responsible for establishing the integrated SATCOM support centers for both global and regional direct support to the combatant commands and other users, 2) Describes DISA's integration responsibilities for the Defense Information Infrastructure and the Defense Information Systems Network (DISN) (to include SATCOM) and end-to-end communications support to combatant commands and other users, 3) Defines the term SATCOM to include DOD use of military-owned satellite communications (MILSATCOM), commercial, allied resources, and other civil segments as appropriate, 4) Refines the user connectivity requirements categories, validation, and processes and expands the responsibilities of the Joint SATCOM Panel (JSP) (formerly the Joint MILSATCOM Panel), 5) Identifies the Joint Staff J6 and OASD (C3I) co-chaired SATCOM Senior Steering Group (SSG) for oversight of SATCOM issues, and 6) Deletes the term System Manager.

market uncertainties, development of foreign systems, and the costliness of the Landsat system.[120]

For decades, high-resolution satellite imaging was dominated exclusively by the United States, Soviet Union, and later, China. The reason was that the technological complexity of high-resolution space imaging restricted this data to a very small number of countries and the commercial applications were limited. While the commercial launch services provided by these states and Europe permitted other nations to develop civilian satellites for communications and scientific research, these satellites had little military utility. However, by the mid 1980s, a reevaluation of U.S. restrictions on the use of satellite imaging systems highlighted the fact that these have important commercial and civil applications. The escalating costs for Landsat led to its commercialization in 1983, while in 1984 the Land Remote Sensing Policy Act turned over Landsat operation to the EOSAT Corporation.[121] In view of escalating costs, the Reagan Administration reviewed the potential for commercialization of space systems, which led to the Land Remote-Sensing Commercialization Act of 1984.

Land Remote-Sensing Commercialization Act of 1984

During the Cold War, the United States and Soviet Union maintained their high-resolution space surveillance capabilities in the strictest secrecy. Most of the images generated by these satellites were so highly classified that the overall security of the system

[120] Dana J. Johnson, Max Nelson, and Robert J. Lempert, *U.S. Space-based Remote Sensing: Challenges and Prospects* (Santa Monica, CA: The RAND Corporation, 1993), p. 7.
[121] *Ibid.*, p. x. The Reagan Administration held that a commercial operation would be more efficient, lower system and operational costs, may encourage market growth, and limit the need for federal funding.

was maintained in most cases. There were, however, the occasional leaks, such as the image of a Soviet aircraft carrier in construction.[122]

The Land Remote-Sensing Commercialization Act of 1984 (known as the Landsat Act) was designed to promote the commercial distribution and use of data from the civilian Landsat remote sensing satellites. Earlier, Congress had understood that these satellites provide a major benefit in terms of managing the Earth's natural resources as well as many other forms of economic activity.[123] Since the ability to remotely sense other countries from space by governmental or private organizations is an extremely sensitive issue, the Act stipulates that U.S. remote sensing activities must be conducted in conformance with international treaty obligations. Thus, the primary purpose of this Act was to transfer remote sensing activities from the public to the private sector. Known as privatization, the intention was to make the acquisition and use of satellite information more economically efficient and less costly to the government, principally by phasing out government funding for operational satellite remote sensing.

The commercialization of remote sensing is different in many respects from satellite communications. For instance, the Secretary of Commerce is responsible for the Landsat system and for contracting with a private company, currently the Earth Observation Satellite Company (EOSAT), for marketing the data that is received from the satellite. U.S. policy maintains the right to acquire and disseminate this data and the obligation to ensure that it is available to all potential users on a nondiscriminatory basis consistent with antitrust laws. As

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[122] In 1984, Samuel Eliot Morrison, Jr., leaked U.S. photos of a Soviet aircraft carrier to *Janes Defense Weekly*, and in 1997 another photo of a Russian aircraft carrier was published. See Bill Gertz, "Happy New Year, CIA!," *Washington Post*, January 1, 1997.

[123] *Land Remote-Sensing Commercialization Act of 1984*, 83 Stat. 202, Sect 8, November 18, 1969, p. 1.

the U.S. Congress noted, "Government oversight must be maintained to assure that private sector activities are in the national interest and that the international commitments and policies of the United States are honored."[124]

Land Remote Sensing Policy Act of 1992

The purpose of this policy was to promote U.S. technological leadership in the field of land remote sensing by providing data from the Landsat program, establishing a new national land remote sensing policy, and repealing the Land Remote Sensing Commercialization Act of 1984. According to Congress, the continuous collection and utilization of land remote sensing data from space provides major benefits for studying and understanding human effects on the environment, managing natural resources, and planning and conducting activities of scientific, economic, and social importance.[125] Landsat data also is important for national security purposes, which explains in part why management responsibilities for the program were transferred from the DoC to the DoD and NASA.

The Land Remote Sensing Act also adopted a policy for data generated by Landsat 7 that encouraged competition within the private sector in the hope that this would lead to the development of a commercial market for data. The overall goal of the Landsat Program Management was to enhance the use of Landsat data by acquiring and operating a capability for satellite tracking and data relay. At the same time, many observers argue that the use of high-resolution images from space will be economically viable, and thus could encourage changes in the U.S. policies that govern the use of commercial remote sensing. As a result, in 1994 President Clinton issued Presidential Decision Directive 23 (PDD-23), which

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[124] *Ibid.*, Sect. 101, p. 13.
[125] H.R. 6133, *Land Remote Sensing Policy Act of 1992*, <http://thomas.loc.gov/cgi-bin/query/C?c102/temp> [March 28, 2001].

allowed private firms to develop, launch, and sell high-resolution satellite imaging services. Shortly afterwards, the U.S. government began to allow foreign access to U.S. commercial remote sensing space capabilities.

Foreign Access to Remote Sensing Space Capabilities, March 10, 1994 (Presidential Decision Directive/National Security Council-23)

The willingness of U.S. aerospace firms to proceed with commercial observation satellites was significantly galvanized by the Clinton administration's PDD-23, which effectively removed many uncertainties that had inhibited the development of commercial remote sensing enterprises. The result was a substantial increase in the number of licenses for commercial observation satellites that were applied for and approved.[126]

Remote sensing from space gives scientific, industrial, government, military, and individual users the ability to collect data for various purposes. The U.S. government operates high-resolution space-based reconnaissance systems for intelligence and military purposes, which by virtue of their ability to collect data in a timely fashion are among the most valuable U.S. national security assets. The coverage afforded by these systems allows the United States to monitor events on a global basis in near real-time. As more nations discover the value of these satellites, there will be increasing pressures to develop indigenous capabilities or purchase data or systems from commercial firms.

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[126] John C. Baker, Ray A. Williamson, and Bret Johnson, *Security Interests and Dual-Purpose Satellite Technologies: Framing the Policy Issues* (Washington, D.C.: Preliminary Draft Dual-Purpose Space Technologies Project, Space Policy Institute, January 2000), p. 15, identified twelve satellite systems: Earth Watch: January 4, 1993; EOSAT: June 17, 1993; Space Imaging: April 22, 1994; Orbimage: May 5, 1994; Orbimage: July 1, 1994; Earth Watch: September 2, 1994; Astro Vision: January 23, 1995; GDE Systems Imaging: July 14, 1995; Motorola: August 1, 1995; Boeing: May 16, 1996; CTA Incorporated: January 9, 1997; RDL: June 16, 1998. Final draft available from <www.gwu.edu/~spi>.

Consequently, the goal of PDD-23 was to support and enhance U.S. industrial competitiveness in the field of remote sensing space capabilities, while protecting the national security and foreign policy interests of the United States. The directive emphasizes the need of the United States to maintain its industrial base, advance U.S. technology, create economic opportunities, strengthen U.S. balance of payments, enhance national influence, and promote regional stability. This policy covers foreign access to remote sensing space systems, technology, products, and data. In terms of commercial licenses for providing this data, this policy includes operating licenses granted under the *Land Remote Sensing Policy Act of 1992* and export licenses for certain items that are controlled by the U.S. Munitions List (USML). While this policy restricts exports of certain items on the USML, any such exports on the USML or the Commerce Control List (CCL) must be licensed in accordance with existing law and regulations.

License requests by U.S. firms to operate private remote sensing space systems are reviewed on a case-by-case basis in accordance with the *Land Remote Sensing Policy Act of 1992*. The presumptive policy is that remote sensing space systems whose performance capabilities and imagery quality characteristics are available or planned for the world marketplace (e.g., SPOT, Landsat, etc.) will be favorably considered for a license. The purpose of this policy is to prevent the transfer of sensitive technologies while encouraging commercial firms to broaden their technological capabilities. By January 1997, the Department of Commerce had issued licenses to nine U.S. companies, some with foreign partners, for 11 different classes of satellites with a wide range of technical capabilities.[127]

[127] *Ibid.*, p. 15.

The guidance for obtaining licenses for satellite remote sensing was outlined in the Commercial Space Act of 1997.

Commercial Space Act of 1997 - Commercial Remote Sensing

The fundamental goal of this policy is to support and enhance the industrial competitiveness of the United States in the field of remote sensing, while protecting U.S. national security interests and international obligations. Since the commercialization of land remote sensing is a near-term goal of U.S. policy, commercial remote sensing has been relatively uncontrolled by government regulation. In part, this is due to the framework that governs spectrum allocation, licensing new systems, and provisions for "shutter control."[128] However, there are concerns that shutter control provisions could generate lengthy interagency disputes or that new policies could lead to further restrictions on remote sensing. A further concern is that the ability to preemptively influence real-time spacecraft operations, even if governed by national security interests, could harm suppliers and customers alike unless these actions are conducted in a consistent fashion.[129]

Under current policy, the U.S. government is encouraged to provide imagery to countries that receive assistance under the foreign aid program. Commercial remote sensing imagery can help the developing world manage its resources and economies much more efficiently. However, members of the House Committee on Science have stated that the U.S.

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[128] Shutter control gives the U.S. government the ability to tell commercial firms to turn-off their imagery capability during time of crisis.

[129] Molly K. Macauley, "*The Commercial Space Act of 1997: Commercial Remote Sensing*," delivered to the U.S. House Subcommittee on Space and Aeronautics, Committee on Science, May 21, 1997.

government should be in the commercial remote sensing business.[130] While the relationship between commercial and government remote sensing remains unsettled, government agencies are working to resolve problems about licensing private remote sensing satellite systems.

Memorandum of Understanding (MOU) Among the Departments of State, Defense, Commerce, Interior and the Intelligence Community Concerning the Licensing of Private Remote Sensing Satellite Systems (1999)

This MOU is consistent with the Land Remote Sensing Policy Act of 1992, 15 U.S.C. 5601 et seq. (the Act), and PDD-23. The Secretary of Commerce is responsible for administering the licensing of private remote sensing satellite systems. The purpose of this MOU is to establish interagency procedures for handling remote sensing licensing actions, and consultations in the event that normal commercial satellite operations are interrupted.

In recent years, the U.S. policy governing the export of satellites and critical technologies has changed, as exemplified by State Department concerns that critical technologies will be transferred or sold to hostile powers. The U.S. satellite companies Hughes and Loral were charged with allowing transfers of information after highly-publicized launch failures in China. This problem was compounded when the Chinese were less than forthcoming about the 1996 investigation of the Loral satellites that crashed. To compensate, the U.S. government established this MOU in order to prevent the release of these sensitive missile technologies.[131]

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[130] Report from the Committee on Science to the House of Representatives on *Commercial Space Act of 1997*, October 24, 1997, <http://www.fas.org/spp/civil/congress/1997_r/h105-347.htm> [March 28, 2001].

[131] Dale M. Gray, "Why has the U.S. State Department Declared War on the American Satellite Industry?," *Space Policy Digest*, <http://spacepolicy.org/page_dg0499.html> [April 2, 2001].

In response to this threat to U.S. security, a provision in the 1999 defense bill transferred control over satellite exports from the Department of Commerce to the State Department, while commercial satellites were reclassified as "munitions." This action was to ensure that technology from advanced American satellites did not reach unfriendly states. This policy allows the Secretary of Commerce, in consultation with other agencies when necessary for national security and foreign policy reasons, to constrain the sale of use of commercial remote sensing systems. As a result, however, foreign satellite buyers are losing interest in buying American built satellites because these new restrictions do not permit them to fully understand what they are purchasing.[132] This MOU establishes procedures for reviewing of licensing actions as that affects the interruption of normal operations and coordinating the release of information.

Policy Directive for Commercial Affairs NIMA 21R, March 1, 2000

This policy supercedes PD 8600R1, which was issued by the same title on September 10, 1997, is designed to improve NIMA's performance by encouraging the use of proven commercial capabilities. In view of increasing customer requirements and diminished resources, NIMA realized that the ability to use commercial solutions was a sensible long-term business practice, which required broad changes in policy.[133]

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[132] *Ibid.*

[133] NIMA 21 Revision, *Policy Directive for Commercial Affairs*, March 1, 2000, p. 1. This policy seeks to "1) Maintain an ongoing information exchange with industry, 2) Team with industry to advance NIMA's technology base and improve needs to customers, 3) Employ mission effectiveness and business criteria to optimize the mix of in-house and outsourced activities, concentrating Agency manpower on core process activities and shifting non-core activities to proven outside suppliers. Further augment core process capacity by increasing commercial market participation, 4) Influence the application of industry resources toward the development of products, services, and open system "plug and play" technologies that better match agency and customer needs, 5) Work closely with industry, the General Services

Following this review of the principal policies and directives that govern the use of commercial space systems, notably, satellite communications and remote sensing, the next section discusses whether these policies and directives are increasing the availability and survivability of commercial space systems for the U.S. government and military.

Administration Federal Supply Service, and other federal agencies to fully employ streamlined acquisition procedures, competition rules, and DOD direction designed to quickly and efficiently tap into commercial marketplace for new technologies, products, and services."

SECTION IV

ANALYSIS AND FINDINGS

The development of space systems has been through numerous thresholds during the last forty years. For the first 20 years, the development of satellite systems was controlled and operated almost entirely by sovereign states, with the exception of limited commercial satellite communications services. The reason was that possessing satellite assets required the technological capabilities and economic resources that were available only to states and international consortia. At the same time, the commercial market for space products and services during this time period was limited because of technological and economic reasons. While the first threshold of satellite proliferation was confined to the great powers, their allies, and international organizations that could afford to develop satellite technology, the second threshold was reached when medium-sized powers joined the satellite club for various reasons, including the prestige and visibility associated with possessing satellite systems.

With the growing maturity of satellite technology and the diffusion of technologies to the commercial sector, commercial firms represent the newest category of space systems owners. The world has now entered the third threshold of satellite development, which suggests that satellite services and products will be available to all states and non-state actors. As a result, the possession of or access to satellite services and products is potentially destabilizing now that hostile parties have ready access to information.[134] More ominously, commercial satellites may deprive the United States of the information that it currently

[134] Dana J. Johnson, Scott Pace, and C. Bryan Gabbard, *Space: Emerging Options for National Power* (Santa Monica, CA: The RAND Corporation, 1998), p. 32.

acquires from its satellites as countries learn to conceal their activities from satellite systems.[135] As a consequence, the increasingly reliance on space assets by the United States and other states and the threats to these assets, means that protecting space assets as well as denying or degrading their use by an adversary have emerged as a critical national security priority for the United States.[136]

In view of the explosive growth in demand for information, the capabilities of traditional military, civil, and commercial firms are converging. The communications and remote sensing satellite industry are being transformed from domination by federal government, military agencies and international consortia of national governments to domination by private sector consortia or partnerships.[137] Since commercial firms are in business to be economically viable, the daunting task for the U.S. government is to manage its relationship with the emerging commercial space sector without impeding its development. At the same time, both commercial firms and the government must adapt to

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[135] Ann M. Florini and Yahya Dehqanzada, "Commercial Satellite Imagery Comes of Age," Issues in Science and Technology, Fall 1999. <http://www.nap.edu/issues/16.1/florini.htm> [April 21, 2001].

[136] According to the Space Commission Report, p. ix, "the present extent of U.S. dependence on space, the rapid pace at which this dependence is increasing and the vulnerabilities it creates, all demand that U.S. national security space interests be recognized as a top national security priority."

[137] Lieutenant General Lance Lord, USAF, stated to the 1998 FAA's Commercial Space Transportation Symposium: "These partnerships, especially with industry, have become critical because of three trends simultaneously impacting the U.S. military, civil, and commercial space sectors. The first trend is the continued decline of defense dollars as a percentage of the Gross National Product and the need to cooperate with civil space partners for more efficient use of resources. The second is the dramatic shift of space pioneering leadership from government to industry after five decades of driving space developments. The third trend is the rapid advance of technology, forcing government to be more adept at leveraging key enabling technologies." Source: Lieutenant General Lance Lord, "Three Considerations for America's Future in Space," speech at the FAA's Commercial Space Transportation Symposium on February 10, 1998, Arlington, Virginia, <http://www.spacecom.af.mil/hqafspc/library/speeches/sp_considerations.htm> [April 22 2001].

the changing economic and security conditions if the development of commercial space systems is to reach its full potential.

Governmental Incentives

The actions and policies that govern commercial space systems must balance the risks and benefits associated with using these systems. This section discusses the incentives and disincentives that govern how government agencies use commercial space systems.[138] There are several incentives that increase the value for government agencies of using commercial space systems.

Maintain National Security. With growing international involvement in the use of commercial space systems, the U.S. government must balance the consequences of losing its dominant position in space systems with protecting its national security and economic interests. With the proper investments of time and money, the U.S. government can maintain its leadership in space and simultaneously improve its ability to protect U.S. national interests. The intent is to avoid relying on a small number of military satellite constellations whose loss could severely hamper U.S. capabilities, while ensuring that the U.S. government does not find itself in the position where it is foraging for essential satellite services during a crisis.

One advantage of government involvement in the commercial sector is to give military and intelligence agencies a better understanding of commercial systems and how best to use these systems in the most effective and efficient fashion. Indeed, better knowledge about the capabilities of commercial systems might help the U.S. military in the

[138] Erwin, p. 20, who noted that, "disagreements prevail about the extent to which government space functions can be fulfilled by commercial systems and whether the government should be financially supporting technologies designed for mass consumption."

immediate future. In addition, increasing the military's familiarity with commercial practices, particularly in terms of newly emerging analytic capabilities in the private sector, might improve how the military uses commercial space systems. As the, commercial environment changes both domestically and internationally, the United States should try to increase its influence by remaining actively involved in the commercial space sector. At a time when states are increasing interdependence in economic and political terms, the prudent option for the United States is to actively shape the rules of the game by building security communities rather than seeking influence through military power.

Enhance National Capabilities. As articulated in *Joint Vision 2020* and other studies, the effort to establish information dominance over potential adversaries through such concepts as network centric warfare and battlefield digitization effectively increases the demand for information. Not surprisingly, commercial space systems are increasingly essential to maintaining U.S. military capabilities, of which the increasing reliance on "reachback" facilities in the United States is an important example of how military forces will use information. Since there will never be sufficient money to support all military requirements, we can expect that the demand for information will increase beyond the ability of the military or the government to collect, disseminate, and use information as well as respond accordingly. Commercial space systems provide one option for meeting this demand because these technologies increase the capacity, coverage, and revisit times of the U.S. military and intelligence agencies. For instance, the USAF Scientific Advisory Board noted that the capabilities of commercial communications services will be "1000 times" greater than the most ambitious plans for military satellite communications.[139] At the same

[139] Correll, pp. 20-25.

time, improving the ability to filter, process, and synthesize information will reduce the need to transmit unnecessary information.

In addition, the acquisition cycle time for technologies is remarkably shorter in the commercial world than it is for the DoD. Commercial satellites with many more capabilities can be purchased and flown much sooner than their government counterparts.[140] For instance, commercial satellites in geosynchronous orbit are available twelve months after the order is placed.[141] For the next generation of small satellites in low-earth orbit, it is three years from the order until the delivery, which is still faster than DoD. Furthermore, acquisition times are likely to improve.[142] As a consequence, the military can take advantage of commercially improved systems while simultaneously reducing its financial risk or share in maintaining obsolete systems.

Maintain Industrial Base and Technological Superiority. Since one element of American strength is its commanding lead in science and technology, the U.S. government must increase its investment in research and development (R&D) if it is to sustain its technological position. In fact, only the government can ensure that the United States has the balanced technology development strategy that is consistent with its long-term objective of sustaining the nation's competitive technology advantage in space. Today, such countries as France, Russia, and India are targeting the commercial space imagery sector to dominate the market. As a result, there must be a balance between national security and commercial interests if the U.S. participation in international markets is to increase. This objective is

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[140] Foley, p. 47.
[141] Moorman, p. 12.
[142] *Ibid.*, p. 12.

consistent with President Clinton's decision to relax the restriction on the sale of high-resolution imagery, as outlined in PDD-23.

The government must fund projects and support people if it is to ensure that the United States has a sustainable industrial base in the future. Government investments contribute to commercial space systems in many important areas, such as space base radar and hyperspectral imagery. In some cases, the government provides the early and critical support that is necessary if these firms are to survive and prosper economically, while maintaining the technological lead upon which the United States depends. In addition, the infusion of capital ensures that the United States maintains its lead in basic research and development in space technologies. While the government provides the primary impetus for technological innovation in basic research, technology development, and concept demonstration, industry has the unique ability to implement technologies and field those technologies in operational systems. In addition, the government must use investments to spur the challenging technical work in space technologies.[143]

Provide Effective, Affordable Services. One argument is that in the long-term, it is more expensive for the DoD to use commercial satellites than to operate its own satellites.[144] However, a study by the RAND Corporation concluded that commercial leases give DoD a valuable option economically, especially if there are long-term commitments to increase

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[143] Booz, Allen & Hamilton, *Space Technology Industrial Base Assessment* (McLean, VA: December 2000).

[144] The following studies have concluded that it is generally cheaper for DoD to own SATCOM as opposed to buying or leasing it on the market: Feb 1995 DISA Phase I Investment Strategy Study, 1996 Space Architect's SATCOM Architecture Development Team, 1997 ANSER Lease vs. Buy Analysis for SAF/AQSS, and 1997 GAO Report, *Defense Satellite Communications.*

communications capacity.[145] In fact, this RAND study determined that it is essential for DoD to determine the right mix of commercial and government systems if the U.S. military is to achieve the communications "throughput" rates that are essential to meeting future operational requirements at current budget levels. At the same time, economic efficiencies are likely to reduce the cost of imagery as firms develop unique software products and applications.

Governmental Disincentives

There are three fundamental disincentives to government agencies establishing dependence on commercial firms.

Commercial Vulnerability. The primary disincentive to increasing the dependence of government agencies on commercial satellite services is the unique role of military requirements. Commercial satellites are not built to the same strict military specifications because military satellites must operate in environments that require such essential non-commercial features as hardening, jam resistance, and beam nulling. Since most commercial firms view space as a peaceful international sanctuary for generating revenue, there is no widespread belief that there are serious threats to commercial space systems or that

[145] Tim Bonds, et. al., *Employing Commercial Satellite Communications: Wideband Investments Options for the Department of Defense* (Santa Monica, CA: The RAND Corporation, 2000), pp. 129-131. The study concluded: (1) Commercial leases provide a valuable option to increase capacity even when DoD buys unique systems; (2) Cost is not the only criteria—sometimes DoD needs to pay more for military operational capabilities; (3) DoD must develop operational concepts that maximize its flexibility in employing commercial and DoD systems; (4) It may be more economical to make long-term commitments and "waste" same capacity than to underestimate need and make up the shortfall with short-term service contracts, and (5) DoD should make choices based on operational characteristics needed not on expected savings.

commercial space systems should be protected. In fact, these firms believe that the increasingly multinational nature of commercial space provides its own form of protection.[146]

Additionally, the various commercial satellite firms do not actively plan for system interoperability or design systems that are interoperable with DoD's "legacy" systems.[147] However, the industry responds to economic arguments. Ideally, a fully integrated, interoperable, and seamless system would provide maximum benefits for both governmental and commercial consumers. Not surprisingly, there are concerns in the military that commercial firms will be more concerned about maintaining their client base and ensuring a return on investment than creating the surge capacity that the military might need in a crisis."[148] A related issue is DoD picking the wrong satellite system or commercial firm, the "VHS tape versus Beta tape" problem.[149]

Increase Adversary Capabilities. Adversaries could use the same commercial satellites systems as the U.S. military, and satellite firms may be unwilling to deny access to those adversaries during a crisis or war. For instance, satellite imagery is particularly important information because it can reveal both large geographic areas and significant details. Since the benefits can be as great as the cost, states as well as sub-national groups could use commercial imagery to collect intelligence, plan terrorist attacks, or mount military operations. All of these factors create complicated conditions under which the U.S. military

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[146] *NDIA/CINCSPACE Summer Study Briefing*, briefed to USCINCSPACE, September 25 1997.
[147] Office of the Under Secretary of Defense, *Department of Defense Report to Congress on Impediments for the Innovative Acquisition of Commercial Satellite Communications*, June 1998, p. 12.
[148] Goodman, pp. 39-41.
[149] Erwin, pp. 20-22.

might be called upon to take action against a satellite that it also relies on for critical information.

Government Loses Control. Commercial space providers play by a set of different rules. Satellite systems that are owned and operated by commercial firms, foreign governments, foreign companies, or international consortia may not respond or act in a timely manner to requests for service from the United States. At the same time, the United States has a limited ability to compel these firms to respond in a timely fashion – for example, to obtain host nation approval or negotiate available transponder space for communication systems.[150] In terms of imagery systems, the U.S. government loses significant control over information when satellite firms can in essence photograph any site and sell those images to virtually any organization. Since the United Nations General Assembly in 1986 adopted legal principles to guide civilian and commercial remote sensing, a state that knows that it is being imaged is entitled to buy copies of that imagery "on a nondiscriminating basis and on reasonable cost terms."[151]

Commercial Incentives and Disincentives

By contrast, commercial firms enjoy certain benefits as well as concerns when dealing with governments. The principal reason for doing business with a government is economic. Dealing with governments is considered to be a significant plus when a firm is raising funds, and in many cases government agencies are the perfect anchor tenant for developing and operating these high-risk space technologies. However, commercial firms do

[150] Commercial SATCOM are subject to International Telecommunications Union (ITU) rules and regulation. ITU rules state electromagnetic spectrum is a national resource and consequently each nation manages its own spectrum at its discretion within its border. Office of the Under Secretary of Defense, pp. 17-19.
[151] Florini and Dehqanzada.

not believe that the U.S. government is a reliable customer given its bureaucratic, budgetary, and security concerns.[152] For example, it is simply not cost effective at this time for commercial firms to meet the government's unique requirements for jamming.[153]

In general, commercial firms are concerned about government intrusiveness and therefore do not want their capabilities dictated by the government, especially since these firms must make design trades that are dictated by their shareholders. To complicate matters, the governmental budget process is an exercise in which funds are allocated annually. Since defense dollars are always in flux, programs are hastily and repeatedly accommodated to reflect these shifts in the overall budgets. And even when funding is approved, funding historically has been cancelled, delayed, or reduced.

In summary, much has been said about the proper balance between commercial interest and national security. An issue that could undermine the U.S. government's commercial satellite policy is whether these systems will be both available and, more importantly, survivable in a crisis or war. Ultimately, firms must accept that active involvement with the government does not eliminate their right to make sound business decisions. Even if government agencies cannot direct how industry operates, government agencies clearly have the power to create chaos in the commercial space market. Therefore, it is prudent for both government agencies and commercial firms to develop strategies for using commercial space system that are consistent with the best interests of all interested parties.

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[152] A good government customer is defined as purchasing services early with long-term commitments (5 years plus) and having stability in its policy.
[153] Office of the Under Secretary of Defense, p. 10.

Policies Are Fundamentally Passive

An important finding of this study is that there are no policy impediments that hinder the U.S. government and military agencies from using commercial satellite systems. However, current policies imply that commercial space systems should play the limited role of filling gaps in national capabilities, which is consistent with the fact that the U.S. military has pledged to use commercial satellite technology to augment its own capabilities as much as possible. Furthermore, the policies of defense and government agencies highly encourage these agencies to pursue commercial satellite systems. As the President's 1996 National Space Policy stated, "U.S. Government agencies should purchase commercially available space goods and services to the fullest extent feasible." Furthermore, DoD Space Policy Directive 3100.10 states that, "when planning for using space use civil and commercial capabilities to the maximum extent feasible and practical (including the use of allied and friendly capabilities, as appropriate) that are consistent with national security requirements." While DoD is integrating commercial satellite communications systems into the MILSATCOM architecture, these services play a secondary role and are not expected to replace any current or future DoD-owned military satellites for operational, technical, and policy reasons.[154]

The problem is that government agencies will need more than "encouragement" if the United States is to increase its use of commercial space systems. Since these policies are passive rather than directive in nature, they are ineffective and bound to fail because agencies are not forced to change their behavior. Therefore, to increase the use of commercial space systems, U.S. government policies must fit the new commercial reality.

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[154] *Ibid.*, pp. 9-10.

The fundamental problem is that U.S. commercial space policy does not change the behaviors, processes, and procedures of government agencies. Under the terms of the current U.S. national space policy, government agencies, specifically DoD, will not commit to aggressively using commercial space systems, and thus the commercial space firms will remain uncommitted to U.S. security needs. While many forthcoming commercial capabilities show great promise, current commercial communications and remote sensing satellites do not fully satisfy the government technical, operational, and policy requirements, including protection, assured access, U.S. control, and interoperability. This effectively limits the use of commercial systems to a supplemental role. However, the unique requirements of DoD systems provide the framework within which commercial solutions must operate. Commercial developers seeking to gain competitive opportunities for military business must consider these requirements and include these in their technical designs and business strategies.

The U.S. government must improve its ability to work with industry to incorporate its requirements into the next generation of satellites, which will depend on establishing long-term commitments to commercial systems. And even though technological innovation could lead to cost effective systems in the future, the commercial sector may pursue the unprotected market. Without effective policy planning and military commercial cooperation in this direction, the U.S. government is unlikely to use commercial communications satellite systems in more than a supplemental role. In view of recent studies and analyses, several issues as discussed below weaken the ability of the United States to use commercial space systems. Importantly, many of these issues have been identified in earlier studies but changes have not been implemented in either policy or practice.

Lack Clear Guidance and Strong National Leadership. This study identified numerous policies throughout U.S. government agencies that address the use of commercial space systems, and found sharply divergent views within the military and government about the value of developing and using these systems. One reason is that there are six layers of governmental agencies involved in the process. First, there is the influence of the President and his personal staff, who have considerable influence on national space policy and military space activities. The next level includes the White House Executive Offices such as the National Security Council, the National Economic Council, and the National Science and Technology. Third, there is the Executive Branch Departments and Agencies (DoD, NASA, DoC, DoT, NSA, and CIA). The fourth level includes the Congressional Committees that have oversight and fiscal authority over space program, such as the Appropriations and Authorizations Committees and the Armed Services and National Security. The fifth level involves Congressional members and agencies such as the Congressional Budget Office and the General Accounting Office. The final level includes public opinion, interest groups, U.S. industry, and various international organizations and governments that are involved in space programs.[155]

Since there are so many involved in the bureaucratic process, it is not possible to resolve the problem by promulgating yet another series of agency-level policies. Instead, the solution is likely to involve more than policy, but strong leadership that establishes the partnership between government agencies and commercial space firms that satisfies the government's unique requirements for space systems. For example, while DoD has presented its top satellite communications requirements to commercial firms, there has been

[155] Johnson, Pace, and Gabbard, pp. 18-20.

little progress because commercial firms have taken the position that their business plans are not consistent with these requirements.[156] The intent is not to have commercial space systems completely replace government space systems because the military will always have stringent requirements that cannot be satisfied economically with commercial products but to determine the right mix.

Another problem is that the U.S. government has lost its monopoly on space imagery and is gradually losing its ability to control what commercial satellite firms generate. As France, China, Russia, Israel, and Canada, among others, increasingly sell imagery products to any organization that can pay, commercial firms selling these products are less amenable to control by the U.S. government. While the DoC and DoS regulate the use of commercial space imagery through licensing requirements, the current regulatory environment (including export controls) is unlikely to reverse the gradual erosion of U.S. technological capabilities. Part of the problem is the failure of the government to support commercial space firms in a timely manner. For example, the government is required to respond to license requests within 120 days. However, the firm Earthwatch waited nearly two years before it received a license to sell 0.5-meter satellite imagery, and there was relatively little discussion with the government on the subject. In fact, once the license application was put into the evaluation process, there was no clear "authority" or forum to provide information or respond to government concerns.[157]

Weakened Space Technology Industrial Base. Today, innovation in the commercial space sector focuses on using existing space technologies and developing applications, which

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[156] Phil Hampton, <hamptonp@navyspace.com> "Comments to Naval War College ARP Paper," [E-mail to John Stocker <stockerj@nwc.navy.mil>] March 28, 2001.
[157] Steve Irish, <sirish@digitalglobe.com> "Policy Questions," [E-mail to John Stocker <stockerj@nwc.navy.mil>] March 28, 2001.

is largely a result of pressures on commercial firms to generate revenues in order to repay their investments.[158] This problem is compounded by the fact that the government approach is to spend fewer resources on developing technologies, while using innovation in the commercial sector to aid government programs.[159] As a result, the government's ability to manage and shape the development of technology is progressively declining, and, in fact, government agencies have cut corporate research and development budgets by roughly 90 percent.[160] The fundamental question is whether the government can successfully harness technological progress in the commercial world without making the appropriate level of investments. The corollary is whether this logic will apply to commercial space systems, and thus whether the U.S. government should use its resources to influence the development of commercial space systems. It is critical to acknowledge that presently commercial demand is not sufficient to sustain a viable space technology industrial base for the future unless the U.S. government invests in critical technologies.[161]

Since commercial satellite imagery firms has depended on funding from U.S. government agencies, it is likely, as exemplified by the cases of Earthsat and Orbimage, that continuous support from the U.S. government will be essential, if these firms are to survive and prosper. For example, 80-90 percent of Earthsat's business is supported by government agencies. However, it should be noted that commercial space imagery firms appear to be economically healthy, as measured by projections that the global market will grow by 10

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[158] Booz, Allen & Hamilton, p. 13.
[159] *Ibid.*, p. 11.
[160] *Ibid.*, p. 11.
[161] *Ibid.*, p. 24. On p. 31, the study goes on to say that the lack of funding has made it difficult for both government and industry to attract and retain the best people. Aerospace Industries Association President John Douglas noted that, "The percentage of U.S. R&D scientists and engineers involved in aerospace was 20-25 percent for the two decades following the 1957 Sputnik launch, but that fraction has dropped to about 7% in 1999."

percent per year. For example, Orbimage whose strategy is to be the lowest cost provider of imagery in several spectra (earth observation, multispectra, hyperspectra and radar), reportedly has a $400 million backlog of commitments, and sees a $14 billion global market on an annual basis.

Interestingly, commercial space imagery firms may be better positioned to accelerate the development of advanced methods for processing data, which would provide an important benefit for U.S. government agencies that invest in commercial space imagery firms. While the U.S. government historically has developed the leading edge technologies in space imaging, recent developments in computer, communications, and Internet technologies suggest that commercial firms could dominate the development of cutting-edge applications for processing the data generated by satellite imagery. If these firms could accelerate the development of processing methods that the government and military find to be immensely valuable, prudent investments by the government could accelerate the pace by which commercial firms advance the state of the art in imagery.

Problems with Centralized Control. Although the government has directly energized and encouraged commercial space firms to enter the market in communications and imagery sectors, the government has not fully utilized these systems. On the other hand, the government has done a better job with communications than imagery. In terms of communications, DISA has primary responsibility in the U.S. government for acquiring and providing satellite communications. Some observers note that DISA is too slow, unresponsive, and inflexible to meet the demand for new communications services that the military commands are likely to need in the dynamic and deregulated telecommunications

market.[162] There are too many instructions and regulations with which government agencies must comply. For example, in the U.S. Navy, 40 percent of its satellite communications are leased through CSCI, which comprises 25-30 percent of its total bandwidth. From the Navy perspective, the CSCI approach to using commercial space systems is cumbersome and non-responsive to Navy requirements because it is not geared to the Navy's mission but to fixed satellite service.[163] In terms of space imagery, there is no incentive for NRO and NIMA to use commercial imagery satellite systems. Although NRO and NIMA planned to spend in excess of $1 billion on commercial satellite imagery, this funding was recently reallocated to cover other higher priority programs.[164]

Inadequate Budgets and Business Practices. Since U.S. government agencies rarely think and operate in commercial terms, the U.S. government rarely makes long-term commitments to use commercial space systems. Commitments made by the U.S. government, principally in terms of commercial satellite communications, are focused on the short term. However, the failure to establish long-term commitments weakens, if not undermines, the ability of the government to maximize the degree of technological progress that is being made by commercial firms and to harness that progress in cost-effective ways. As exemplified by leases for commercial satellite communications, the problem is that the U.S. government bases its purchases on short-term operational needs.

The critical risk is that the government will invest in commercial technologies only to find that it has invested in obsolete technologies. The case of Iridium provides an important example. Early investments in Iridium that DoD offered to make were outpaced by

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[162] Johnson, Pace, and Gabbard, p. 29.
[163] Hampton.
[164] NRO and NIMA representatives, author interviewed, March 23, 2001.

developments in the cellular telephone market and if pursued could have saddled the U.S. military global satellite communication technologies. A related concern is that government agencies would rather use the apparently free services provided by government imagery or communications agencies than invest in commercial firms that provide these products.

Low Understanding of Space Systems Threats. As stated earlier, commercial space systems are so important to U.S. national and economic interests that potential adversaries could believe that disrupting service provides an important element of an asymmetric strategy for dealing with the United States. If commercial firms are unaware of potential threats to space systems, their long-term value to the United States is diminished, and it weakens the ability of military and intelligence organizations to use these systems. For instance, it is commonly the case that representatives from commercial space firms are not informed on a highly-detailed level about existing threats, which means that there is no consensus on the types of protection that are required.[165] In addition, government agencies and commercial firms have different views on the need to protect commercial space systems. However, when there is agreement on potential threats, the possible loss in service has immediate economic implications. The countervailing problem is that responding to these threats translates into adding weight and hence costs to satellites.

In summary, the purpose of this study was to determine if a new framework for U.S. government agencies that shapes the use of commercial space systems in the twenty-first century is needed. It is important to note that commercial space systems will never completely replace military systems for reasons related to economic and operational requirements. The military will always have stringent requirements that could not be

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[165] *NDIA/CINCSPACE Summer Study Briefing.*

satisfied economically with a commercial product for specific missions. On the other hand, there are many requirements that do not necessarily have to be satisfied with a dedicated military system.[166] Despite the national security implications, U.S. policies that govern commercial satellite systems lack the long-term perspective that is necessary if commercial satellite systems are to fulfill their promise. It is essential for the U.S. government and especially DoD to reexamine this issue if the United States is to strike the proper balance between commerce and national security.

[166] As USAF Gen. Richard B. Myers, Vice Chairman of the Joint Chiefs of Staff, stated, "The future of military space calls for an increased reliance on the civilian sector." Myers went on to say, "There's clearly a lot more we can do with space capabilities. We shouldn't be investing a lot of money in things the civilian sector can do." See "Myers: Future of Military Space Requires Use of Civilian Capabilities," *Aerospace Daily*, May 8, 2001.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

A number of commercial firms, international consortia, and such nations as India, China, France, Russia, and Canada are challenging the U.S. government preeminence in space. As the United States becomes more dependent on space technologies and systems, commercial satellite firms are seeking to develop new applications for both governmental and private sector customers. In view of the current budget environment and its growing dependence on space systems, it is essential for the U.S. government to sharpen the policies that govern how agencies should invest prudently in commercial space systems.

When we began this study, a principal assumption was that many U.S. government policies and directives governing the use of commercial space systems were in need of revision, in particular because communications and remote sensing satellites are increasingly central to the ability of the United States to meet its national security objectives. Under the terms of the existing U.S. national space policy, the DoD will not be able to maintain its relationship with the commercial space industry, while simultaneously ensuring that commercial firms remain committed to U.S. security needs. As a result, strong leadership and strategic partnership initiatives in space affairs are needed in order for the United States to receive industry's fullest attention and support.

Based on an examination of these policies, the following recommendations are designed to balance increasing the use of commercial space systems with protecting U.S. national interests and security.

(1) Reorganize for Effective Policy Implementation

(2) *Develop a National Space Security Strategy*

(3) *Invest in critical technologies to maintain the Space Technology Industrial Base*

(4) *Become better consumers of commercial space systems by establishing a budget process that simplifies the ability to use commercial space systems products and services*

(5) *Establish and comply with standards and procedures for commercial space system interoperability, export control, and licensing*

(6) *Educate industry on the threats and risk to space systems*

1. The U.S. government must be reorganized for more effective implementation of space policies, of which more directive and active policies are critical.

The United States has reached the time when it must redesign its space policy. One reason is that the commercial space industry emerged much more quickly than many analysts and officials expected. At the same time, the U.S. government has not shifted its policies and actions to take full advantage of these fundamental changes. Since U.S. policy must shape an international order that is consistent with growing commercial activities, the United States should use commercial space firms to increase its capabilities at a time in which defense budgets are unlikely to increase significantly.

For this policy to succeed, U.S. government agencies must be directed to use commercial space systems first, and if such systems are not available or capable of meeting government requirements, then the government agency should be required to submit a waiver that permits the development or use of a unique government system. This policy will depend on high-level guidance that is promulgated by or directly supported by the President of the

United States or the Secretary of Defense, and supported by the Congress. For instance, the U.S. government established a precedent for this policy when the Clinton administration directly encouraged commercial firms to enter the market for space imagery by the issuance of the land remote imaging directive. Hence, government policy spurred the development of the commercial space imagery market, and directed NASA to commercialize all of its satellite communication by the year 2005. With this policy, the government decisively accelerated the use of commercial space systems by all government agencies in the future.

Most commercial space firms provide information services as well as leadership in developing and operating the space systems that are steadily migrating to the commercial sector. This level of growth in commercial capabilities suggests that U.S. adversaries no longer must be space-faring nations to gain the military benefits associated with space systems. The problem is that critical military space services are increasingly available to organizations that are willing to pay. As the Report of the Commission to Assess United States National Security Space Management and Organization noted in January 2001, presidential leadership is essential if the United States is to gain the maximum benefit from commercial space systems.[167]

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[167] Space Commission, pp. ix-x, which noted that, "U.S. national security space interests must be recognized as a top national security priority. The only way commercial space systems will receive this priority is through specific guidance and direction from the highest government levels. Only Presidential leadership can ensure the cooperation needed from all space sectors—commercial, civil, defense and intelligence." The Commission also concluded "(1) the Secretary of Defense and the Director of Central Intelligence must work closely and effectively together, in partnership, both to set and maintain the course for national security space programs and to resolve the differences that arise between their respective bureaucracies; (2) the U.S. must develop the means both to deter and to defend against hostile acts in and from space, and (3) investment in science and technology resources—not just facilities, but people—is essential if the U.S. is to remain the world's leading space-faring nation. The U.S. Government needs to play an active, deliberate role in expanding and deepening the pool of military and civilian talent in science, engineering and

While there is no simple way to reorganize the government agencies that manage U.S. space policy, there are several steps that will help the United States to reorient the fundamental policies that govern the use of commercial space systems.

First, there must be a review of the fundamental assumptions behind space capabilities and the policies that govern those activities. The President should establish a commission whose mandate is to review the assumptions on which the United States uses space for military and economic purposes. The primary function would be to organize the disparate efforts and ideas about space that are scattered throughout government, research organizations, academia, industry, multinational industry, and international community into a coherent statement for implementing fundamental changes in U.S. policy. This commission will serve to integrate the views of the executive and legislative branches of government into assumptions that provide a consistent basis for policy. It is important that the monastic guardians of the old space theories and policies do not dominate the commission, but includes a comprehensive group of individuals who are open to redefining national space policy if they find the case persuasive.

Second, the President of the United States must outline the nature of the fundamental changes in space policy. The U.S. government can implement a fundamental change in its space policy, but only with the leadership and prestige of the Office of the President. There is no public official, except the President, who can establish a meaningful debate on space proliferation that takes into account government, commercial, and international perspectives on how best to change current U.S. policy.

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systems operations that the nation will need. The government also needs to sustain its investment in enabling and breakthrough technologies in order to maintain its leadership in space."

Third, the U.S. government needs to focus its space policy efforts in a cabinet-level official to provide clear guidance and strong national leadership. National security space organization and management today fail to reflect the growing importance of space to U.S. interests. The present lack of a focal point for shaping and implementing space policy produces the inevitable result when a morass of conflicting agendas and initiatives focus on keeping the existing share of resources. The United States needs clear high-level direction on space.

The United States needs to establish responsibility in a single, cabinet-level official who has a mandate from the President to organize and implement a forward-looking policy for managing space. With presidential support, this individual must begin by creating a central point for the coordination of the policy efforts of the national security bureaucracies. Whether it lies within the DoD or the DoS is less important than the existence of central management. The first step is to recognize the importance of space to: (1) maintain national security, (2) enhance national capabilities, (3) maintain industrial base and technological innovation, and (4) provide effective and affordable services.

At the same time, the DoD and the U.S. Air Force should appoint a space czar who is responsible for directing and coordinating how DoD organizations use space systems. This czar will only be successful in increasing the use of commercial space systems if this individual has the authority to promote opportunities in commercial space technologies and the budget and execution authority required to implement these opportunities. Furthermore, oversight of space policy needs to be coordinated with acquisition and technology development and with command and control, intelligence, and information operations in support of military operations.

In addition, USCINCSPACE should represent the other CINCs. The U.S. SPACECOM UCP and CJCSI 6250.01 Satellite Communications support USCINCSPACE's role and his responsibility to advocate and provide the recommended apportionment of SATCOM to include commercial SATCOM. UCP 99 assigns USCINCSPACE the responsibility to serve as the single point of contact for military space operational matters to include SATCOM as per CJCSI 6250.01. Therefore, USCINCSPACE should take a more active role, if the not the lead, for building partnerships, memoranda, and contractual agreements with industry. USCINCSPACE should also work in coordination with the other regional CINCs to establish relationships with space-faring nations within other "CINCdoms" to obtain needed commercial space capabilities.

Fourth, DoD must decentralize how its uses commercial space systems. The parochial nature of the organizations that manage communications and imagery creates a highly bureaucratic, complex, and unresponsive process for purchasing commercial products. This process could be improved by giving the Services, regional commanders, and CINCs the ability to obtain commercial space services directly from commercial firms. But first, government users need better insight into commercial space systems and operations if they are to use these systems more effectively and efficiently. Given knowledge about their collection capabilities and timeliness, government agencies would become more familiar with the commercial archival data and analytic capabilities that allow the government to better use commercially derived information.

One way to increase this knowledge is to conduct operational experiments with commercial space systems. Only in this way will military and intelligence agencies be able to resolve empirically the question of whether commercial space systems are of value. Such

operational experiments that are conducted with commercial space systems will give military operators and government users a better knowledge and understanding of commercial space systems and their capabilities. Not only will such experiments show government agencies how to obtain commercial space services, but also show the importance of planning ahead for making funds available early to ensure commercial space services are available. In addition, the government must educate the users that the apparently free imagery and communications services from the government are not free.

2. The U.S. government must develop a national space security strategy.

Despite the importance of the U.S. commercial and civil space sectors to national security, the U.S. government does not have a comprehensive policy or strategy for incorporating those capabilities and services into its national security space architecture. Nor does it have well-defined policies and strategies to enhance the competitiveness of the commercial space sector. Regardless of whether budgets decline or expand, the U.S. government will increasingly rely on these systems in part because it has a stake in whether commercial space firms succeed. But to complicate matters, these commercial capabilities will be available to virtually any organization, including potential adversaries.

Despite government efforts to restrict the transfer of sensitive technologies, commercial sources of information technology are spreading in a rapid and irreversible fashion. For instance, commercial satellite imagery not only provides information for U.S. military operations, but unlike imagery from U.S. spy satellites, those same commercial space systems could provide information to U.S. allies and adversaries. As foreign militaries integrate information technology and public sources of information into their operations, global information transparency will continue to erode the dominant position enjoyed by the

U.S. military. Since it is inevitable that states will use transparency to their advantage, the United States must articulate a national space strategy that explains how the United States intends to deal with these matters. This strategy should rest on three elements.

The first part should describe the strategic environment, including the opportunities and challenges that exist when governments, commercial firms, and foreign firms use space systems. It is likely that globalization, advancements in information technologies, and increasing use of space-based components of information systems make space even more important to the United States. Accordingly, the United States cannot afford to abandon the use of space or cede control of space to others.

The second part of the strategy should describe how to integrate space systems that meet U.S. national goals and objectives. The United States must realize that success in the information age depends on harnessing commercial technologies and military operations into unified capabilities that enable the United States to defend its interests in the presence of information transparency. Therefore, the most significant near-term challenge is to further integrate space systems in the intelligence, surveillance, and reconnaissance domains into operational plans. The advent of global information, which has been largely enabled by space, when coupled with effective command and control, targeting, stealth, timely damage assessment, and precision weapons delivery creates a formidable military capability that can defend U.S. national interests well into the future. Therefore, this strategy should describe how the United States would control and defend its assets in space. As with the U.S. National Military Strategy, this space strategy should minimize the chance that the U.S. military will be forced to forage for commercial services. For example, the DoD could pre-position communications and imagery satellites for use in emergencies, which is similar to

the stockpiles of military equipment and supplies that are located around the globe. The proper philosophy is not to worry that these resources might go to waste, but to be happy that those supplies are there when we need them, and happier still if we do not need them at all. Analyses have shown that it is cheaper for the U.S. military to purchase capabilities in advance and waste some of these than it is to wait for a contingency before purchasing those capabilities.[168] In addition, this space strategy should review provisions for shutter control, geographical restrictions, protection, denial, imagery disclosure and foreign access, and international obligations, such as frequency allocation.

The third part of this space strategy should describe how the United States executes that strategy. An important principle for the United States is to protect and augment the national utility represented by commercial space systems, while expanding how civil, governmental, and commercial organizations uses these systems. For example, denying imagery to potential enemies would undermine the market for U.S. companies, and thereby relinquish the market to the foreign firms with which U.S. firms compete. The reason is that potential customers who believe that their access to imagery may be cut off are likely to build commercial relationships with more reliable providers. While the United States often benefits from transparency, its space strategy must ensure that transparency does not harm U.S. interests and security. A related point is that the military services and regional commanders in chief must develop space strategies and concepts of operations for each theater, while addressing the second and third order effects of using both military and commercial space systems.

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[168] Bonds, pp. 129-130.

3. The U.S. government must invest in critical technologies if it is to maintain the nation's space technology industrial base.

Government agencies are undoubtedly aware that they generates several unique technological niches in which they are the only customer, and that the commercial market cannot satisfy all government needs. On the other hand, there are capabilities that will help both the governmental and commercial sectors if there is sufficient funding. Since the commercial space industry is still in its infancy, existing commercial demand is not adequate to sustain, by itself, the necessary technological base without long-term investments from the U.S. government.[169] The result is that commercial satellite firms depend on funding from U.S. government agencies for survival and prosperity, as exemplified by the cases of Earthsat, Orbimage, and Iridium. Furthermore, establishing global partnerships will help to strengthen U.S. space capabilities by leveraging civil, commercial, non-U.S. intelligence, national, and international space programs in order to maintain technological and economic momentum.[170]

4. The U.S. government must become a better consumer of commercial space systems by establishing a budget process that simplifies the ability to use commercial space systems products and services.

As a general proposition, the U.S. policies that govern the use of commercial satellites lack the long-term perspective that is necessary for the health of the commercial

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[169] Booz, Allen & Hamilton, p. 35, General Thomas Moorman Jr., USAF (Retired) stated in an American Institute of Aeronautics and Astronautics speech "...the financial health of the industry mandates a closer partnership between the customer and supplier. This partnership must be based upon improved communications, and a mutual appreciation of the challenges facing both sides...Changing the tone in industry-government relations will require a resource that's often more precious than gold-attention."

[170] *Ibid.*, p. 33.

space industry. The U.S. government must make long-term commitments in commercial space systems, which would rest on long-term funding as well as early and regular investments in commercial space firms. One method is to use multi-year authorizations and biennial appropriations.

In practical terms, the U.S. government should establish budgets that will allow military and government users to purchase commercial space products and services. That is, government and military customers must be able to deal directly with commercial firms rather than the traditional government agencies whose highly bureaucratic, complex, and unresponsive behavior is antithetical to what commercial firms need if they are to survive. To encourage government users to increase their use of commercial space products, U.S. national space strategy should create mechanisms by which operational and specified commands have the budget authority to purchase commercial space products directly from commercial firms in a routine, flexible, and simple fashion. This option is likely to find favor with Congress because it will help organizations minimize the bureaucratic delay that impedes the use of commercial space systems, which in turn spurs the Congress to use "plus-ups" in the budget to support commercial space firms. More importantly, the policy would require the military to think and operate more like commercial firms.

One way to fund this option is to shift resources from the government agencies that control the use of commercial space systems, notably the NRO, NIMA, and the DISA. While these organizations would continue to define standards, monitor future resources, and supervise development endeavors with commercial space firms as well as future acquisition, the day-to-day use of commercial space systems would remain the responsibility of the user. One way to reallocate funds is to emulate the model employed by the military test

community in which resources are reallocated from the test community to the operational commands, which now pay for their testing requirements. This approach has made the testing community more competitive, efficient, and cost effective. Using this same approach, all government and commercial providers would compete for dollars from the users for their specific products (i.e., imagery and communications). In this way, NIMA imagery, for example, would no longer be free to government users, and the military services would pay for all commercial and government products that they use.

5. The U.S. government must establish and comply with standards and procedures for commercial space system interoperability, export control, and licensing.

The U.S. government should establish interoperability standards for all satellite systems in the same fashion that commercial software developers adhere to Internet standards. This measure would minimize the risks associated with the government selecting the wrong system or technology, while ensuring that all government and commercial users can operate together.

The same is true for export controls and licensing processes, which must promote commercial space systems while paying attention to critical national security concerns. Today, the U.S. commercial space industry is encumbered by federal regulations, trade restraints, and contracting inefficiencies, which explains in part why many nations are backing away from regulation and controls on commercial satellite systems so that they can expand their market share and access. For example, export control procedures and regulations drove the Canadian government to award a contract to an Italian firm to build a

radar satellite rather than to seek a U.S. company.[171] This problem was noted in the Report of the Commission to Assess United States National Security Space Management and Organization.[172] For this reason, the U.S. government should adopt an approach that takes into account the effect of selling commercial space products to foreign nations. Ideally, the U.S. government could play the role of an honest broker in order to generate useful and creative ideas for helping U.S. firms dominate the commercial space market, which would give the United States more leverage to impose limitations and restrictions as well as prevent violations.

At the same time, there must be uniform standards and procedures for exporting and licensing commercial space systems. At present, the DoC and DoS have established procedures but consistently fail to comply with their own time limits for licensing, which effectively compromises the ability of U.S. firms to compete in today's fast-paced and dynamic international markets. The current process routinely generates long delays in granting license approvals.[173] For political and economic reasons, it is imperative for U.S. firms to receive timely responses from the U.S. government in either granting or denying licenses. In most cases, there is no reason why the government cannot adhere to the 120-day timeline that it has established for responding to license applications. The result, which has worrisome implications for U.S. security, is that commercial firms are aggressively seeking investments from foreign governments and investors.

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[171] Space Commission, p. 73.
[172] *Ibid.* "U.S. Government policies should encourage the U.S. commercial space sector to earn as much of the international commercial space market as possible."
[173] *Ibid.* "Industry reports many instances in which it took months to get permission to hold a meeting with a close U.S. ally, and in one case took weeks to get permission to make a phone call to a foreign entity."

The licensing process should be guided by clearly defined and enforced mechanisms so that when commercial concerns are raised by U.S. government agencies, commercial firms would have greater opportunities to respond. Finally, the government should establish "safe harbor" guidelines that clearly delineate the guidelines for determining when new license applications will be presumptively approved. To be successful, these guidelines should be broader than those that are covered by the current policy, should grant presumptive approval when commercial space systems are equal to current or planned foreign capabilities, and finally, should not unduly burden the commercial space industry when U.S. national security is not at risk.

6. The U.S. government must educate industry on the threats that pose a risk to space systems.

The U.S. Department of Defense should educate commercial space system companies on the risks and threats faced by these firms, which should help these firms develop more robust business models. At the same time, U.S. government should encourage industry to negotiate minimal standards for protecting commercial space systems. This would serve as the basis upon which commercial firms do business with the government. Finally, the government should provide technical and economic assistance to help commercial space firms develop the necessary hardware and software that will protect commercial satellites.

Additionally, it is critical for government agencies and commercial firms to know the specific capabilities and limitation of commercial space systems as it relates to supporting military operations. As discussed earlier, a series of operational experiments would significantly improve the military's understanding of the capabilities of commercial space systems, and would allow commercial firms to gain more knowledge about government

operations and technical needs. In the end, the U.S. government and commercial firms should establish arrangements for using commercial space systems that serve the interests of both the government and the private sector.

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